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COMPILATION OF STATE DATA FOR EIGHT SELECTED TOXIC SUBSTANCES

VOLUME I
FINAL REPORT

PRICES SUBJECT TO CHANGE

SEPTEMBER 1975

FINAL REPORT

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Washington, D.C. 20460

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COMPILATION OF STATE DATA FOR EIGHT SELECTED TOXIC SUBSTANCES

VOLUME I

MITRE CORPORATION

PREPARED FOR
ENVIRONMENTAL PROTECTION AGENCY

SEPTEMBER 1975

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16. ABSTRACT

In June 1974, the Office of Toxic Substances, EPA, contracted with MITRE to collect and analyze toxic substances data in the U.S. In the next 14 months, MITRE contacted agencies in 20 key states and collected and analyzed their monitoring data. This report describes that effort and discusses the amount, type and usefulness of the data and the toxic substances monitoring capabilities of the state agencies contacted.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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COMPILATION OF STATE DATA FOR EIGHT SELECTED TOXIC SUBSTANCES

VOLUME I
FINAL REPORT

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SEPTEMBER 1975

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INTRODUCTION

In line with its responsibility for assessing risks associated with toxic substances occurring in more than one environmental media, the Office of Toxic Substances (OTS), Environmental Protection Agency (EPA), contracted with The MITRE Corporation to obtain available ambient toxic substances data and information from state agencies. MITRE agreed to contact monitoring agencies in as many states as contract resources allowed. The objectives of this project were the following:

- Assess toxic substances monitoring capabilities of state agencies.
- Collect available state toxic substances data and assemble a data base.
- Summarize and analyze the data for basic statistics (minimum values, maximum values, annual means, standard deviations).
- Analyze the data in terms of its availability, nature, and usefulness to EPA.

In the course of this project, a variety of monitoring agencies were contacted in 20 states and available toxic substances data was collected and analyzed. This final report discusses the toxic substances monitoring capabilities of the agencies contacted, describes the toxic substances data base that was acquired, presents the statistical summaries and analyses of the available data, and analyzes the availability, nature and usefulness of the state data to EPA. Complete, detailed

accounts of the meetings with each agency and discussions of the analysis performed on each portion of toxic substances data received is contained in the four Quarterly Technical Summary Reports,[1,2,3,4] submitted to OTS during the course of the project.

For the convenience of potential users, MITRE has divided this final report into five volumes, as follows:

- Volume I: Collection and Analysis of Toxic Substances Data from State Agencies - Final Report
- Volume II: A Directory of State Toxic Substances Monitoring Agencies
- Volume III: Data and Information Sources Used in the Course of the Study - An Annotated Bibliography
- Volume IV: Compilation of the Summaries and Analyses of State Data
- Volume V: Monitoring Program Capability Descriptor Tables

Volume I is the overall discussion of the results of the project, including the summary, conclusions, recommendations, and main text. The main text of Volume I is comprised of three principal sections: Overview of Project Results, Description of State Toxic Substances Monitoring Capabilities, and Toxic Substances Problems as Perceived

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1. Roberts, et al. Quarterly Technical Summary Report M74-103 (The MITRE Corporation, October 1974
2. Roberts, et al. Second Quarter Technical Summary Report M75-3 (The MITRE Corporation, January 1975)
3. Roberts, et al. Third Quarter Technical Summary Report M75-27 (The MITRE Corporation, April 1975)
4. Roberts, et al. Fourth Quarter Technical Summary Report M75-57 (The MITRE Corporation, August 1975)

by State Agencies. The first section is a review of the approach and history of the project. The second section describes agency capabilities based on information MITRE obtained from each agency on 25 key monitoring program descriptors. Included here are such items as size of networks, number of samples per year, major equipment available, quality control procedures, amount and nature of toxic substances data generated, and anticipated future capabilities. The third section, Toxic Substances Problems as Perceived by State Agencies, is an overall analysis of what was learned about each of the toxic substances of interest from a review of MITRE's summary and analysis of the available data and from discussions with agency officials in each of the states.

Volume II of the final report is the Directory of State Toxic Substances Monitoring Agencies. For all 20 states MITRE representatives visited, information is provided on each agency which as been involved in monitoring any of the toxic substances of interest. The information includes official agency name, address, and name and phone number of the key toxic substances point-of-contact in the agency.

Volume III is Data and Information Sources Used in the Course of the Study - An Annotated Bibliography. This volume contains references and a brief description of each piece of toxic substances data and information collected from agencies in the 20 states visited. Referenced materials include raw data sheets, computer printouts, published articles, memos, annual reports, and other documentation.

A cross-reference index is included so that the bibliography may be entered either by state or by specific toxic substance. This volume serves as the index to the toxic substances data bank turned over to OTS at the completion of the project.

Volume IV is the Compilation of the Summaries and Analyses of State Data. This volume includes a discussion, summary, and analysis of the state agency data collected and processed in the course of the project. The detailed information contained in this volume serves as the statistical analysis data base for the discussion of toxic substances problems contained in Volume I.

Volume V contains the Monitoring Program Capability Descriptor Tables. This volume comprises 160 tables containing information on toxic substances monitoring capabilities in 25 areas for each monitoring agency and each toxic substance monitored. The tables serve two purposes for the final report. Individually, each table provides an evaluation of each agency in a state for monitoring each toxic substance of interest. Taken as a whole, the 160 tables are a data base useful for performing any number of cross-tabulations and analyses based on the 25 descriptors, geographical areas, program areas, and toxic substances. The discussion of agency capabilities in Volume I is based on summaries and analyses of the capability descriptor tables.

Throughout the following sections of the final report, it is important to bear in mind the specific scope of the project. MITRE

is reporting on the toxic substances monitoring capabilities and toxic substances data of a variety of non-Federal agencies in the 20 states contacted. It was not the purpose of the project to make a comprehensive assessment of the risks associated with toxic substances on a national scale based on all available knowledge. Table 1 summarizes the scope and objectives of the project.

Table 1

PROJECT SCOPE AND OBJECTIVES

INCLUDED	NOT INCLUDED
• Assess Monitoring Capabilities in 20 States	• Assess Total National Monitoring capabilities
• Assemble Data Base with Ambient Data from 20 States	• Collect Emissions Data
• Summarize and Analyze Data Statistically	• Collect Data from All Potential Data Sources
• Assess Availability, Nature and Usefulness of Data to EPA	• Perform In-depth Analysis of All Data
	• Perform Comprehensive Interpretation of Toxic Substances Data

SUMMARY

OTS contracted with the MITRE Corporation to collect and analyze post-1970 data on a specified list of toxic substances under a 14 month contract. The list was comprised of the following substances: arsenic, beryllium, cadmium, chromium, cyanide, lead, mercury, polychlorinated biphenyls (PCB's), aryl phosphates, benzene, 3,3' dichlorobenzidine, ethylene glycol, hydrazine, methyl chloroform, "MOCA" (4,4' methylene bis 2 chloroanaline, α napthylamine, acrylonitrile.

In the course of the project MITRE contacted toxic substances monitoring agencies in 20 states. As described in the Overview of Project Results section of the main text, states where agencies were to be contacted were selected by MITRE in consultation with OTS and Regional Offices in order to achieve a representative mix of geographical location, population density, and industrial versus rural economy. By contacting agencies within these states MITRE found that a wide variety of agencies were involved with monitoring some of the toxic substances. The types of agencies contacted included state departments of environment (all media), health, agriculture, fish and wildlife, natural resources, public water supply, and sanitation.

When MITRE determined that a number of agencies in a state monitored some of the toxic substances of interest, meetings were scheduled to discuss the agencies' programs and to make arrangements for

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acquiring the available toxic substances data. Copies of the agencies' data were either obtained during the meetings or arrangements were made to have the data compiled and mailed to MITRE. When the data was received, the MITRE project staff processed it to usable formats and performed basic statistical summaries and analyses including minimum values, maximum values, annual means, and standard deviations.

After contacts had been made with 20 states and data was obtained from agencies in the 20 states, MITRE began the process of preparing the final report. In order to fulfill the project objectives, this included assessing the monitoring capabilities of the agencies contacted, assembling the data base from the state data collected, compiling the statistical summaries and analyses of the state data, and assessing the availability, nature and usefulness of the data to EPA.

To assess state monitoring capabilities, MITRE in the course of the project asked each agency to provide information on 25 key monitoring program descriptors. This information was assembled on tables for each state and each toxic substance monitored. The 160 tables (one for each of 20 states and each of eight toxic substances) have been published as Volume V to this final report. The tables were then cross-summarized and analyzed for the monitoring capabilities discussion in the main text of this volume. In addition, Volume II was published as a directory of all agencies and officials in the 20 states providing toxic substances data and information.

The toxic substances data base was assembled by state and includes the agencies' raw data as received, MITRE's tabulation of

the data in more standardized formats, and computer printouts and punched cards for the data which was computer-processed. Volume III was published as an annotated bibliography of the available state data, with a cross-reference to retrieve the data either by state or toxic substance.

Statistical summaries and analyses were performed as data was received in the course of the project and has been published in the four quarterly reports referenced in the introduction. For the final report the results of the summaries and analyses of state data were compiled and published as Volume IV.

Finally, the availability, nature and usefulness of the state data to EPA are discussed in the conclusions, recommendations, and main text of this volume, with reference to the more detailed information in Volumes IV and V.

CONCLUSIONS

In the course of this project, personal contact was made with officials of nearly 100 agencies in 20 states involved with monitoring toxic substances. Additionally, information provided by these agencies on their monitoring capabilities was analyzed, and the actual monitoring data they submitted was summarized and analyzed statistically (see Volumes IV and V). As a result of these activities, it is possible to draw certain conclusions regarding the capabilities of the states in toxic substances monitoring, and regarding the availability, nature and usefulness to EPA of the data being generated. This discussion is presented in terms of overall conclusions, and specific conclusions by toxic substance monitored and agency.

Overall Conclusions: Agency Capabilities

1. In each of the 20 states visited, one or more agencies have the present capability to monitor some of the toxic substances of interest. Whether or not a particular substance is actually monitored appears to depend upon two main factors:

   a. Availability of equipment (atomic absorption unit, mass spectrophotometer, or X-ray fluorescence unit for metals, and mass spectrophotometer or gas chromatograph for PCB's, other organics and exotic compounds)

   b. A demonstrated need to monitor the substance (such as local contamination problems, or state or Federal regulations requiring monitoring).

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Where both of these criteria are satisfied, agencies do conduct monitoring for toxic substances.

2. In the 20 states contacted, some monitoring was conducted for one or more of the following substances: arsenic, beryllium, cadmium, chromium, cyanide, lead, mercury, and PCB's. For the remaining nine substances on the OTS list of toxic substances of interest, no agency contacted conducted routine monitoring although several indicated they had done occassional tests recently. Those nine substances are aryl phosphates, benzene, 3,3' dichlorobenzidine, ethylene glycol, hydrazine, methyl chloroform, "Moca" (4,4' methylene bis 2 chloroanaline) α napthylamine, and acrylonitrile.

3. With regard to future capabilities, over 85 percent of the agencies contacted felt they had the equipment and trained personnel to monitor additional toxic substances on the OTS list not presently monitored if they were required to do so, and if a method of analysis were available. Virtually every agency believed, however, that an additional analytical burden would require additional funds for staff and equipment.

4. In all but a very few agencies, the method of analysis employed for each toxic substance was referenced to a recognized standard method. In areas where EPA has recommended standard methods and procedures, these were used by most agencies. In other areas, agencies referenced the standards as set forth by the American Public Health Association, the Association of Official Analytical Chemists, the Food and Drug Administration, and the U.S. Department of Agriculture. Based on the information provided by the agencies,

it may be concluded that standard methods of analysis are employed, so that on that basis data from different agencies is comparable.

5. Of 95 agencies contacted in the 20 states, only three had no active quality control program. All of the remainder had at least internal programs, which included regular calibration and maintenance schedules, standards for checking methods, equipment and personnel, and the scheduled running of duplicate samples. In addition, the majority of the agencies participated in interlaboratory testing with other state and local agencies and with the appropriate Federal agencies (EPA, FDA, USDA, etc.).

6. Except for fish and wildlife agencies, most agencies operated their own laboratory facilities, or had control of their own laboratory section within a larger laboratory system. The majority of fish and wildlife agencies either relied on other state laboratories or contracted with private laboratories for toxic substances analysis.

7. On the average, for all state laboratories involved with toxic substances monitoring, there were 38 personnel per laboratory of whom 16 were degreed chemists. The ratio per laboratory is one degreed chemist for each 2.5 employees. While there is no meaningful method of judging the skills and qualifications of the chemists, the numbers alone suggest a good capability for toxic substances analysis.

8. When asked what type of assistance from EPA would be most helpful in their toxic substances activities, agency responses were split fairly evenly into three categories. These were a.) standards promulgation including both safe limits of a substance in the environment, and development of standard methods of analysis; b.) funds for more personnel and analytical equipment; and c.) a wide range of other agency-specific assistance (such as training, enforcement assistance, etc.) Other assistance specific agencies mentioned is shown in the tables of Volume V.

Overall Conclusions: Data Availability

1. While many agencies were sensitive to having additional requirements put upon them for submitting data, in no case was there refusal to cooperate with MITRE representatives in providing information and data. Including that data which had already been submitted to SAROAD, STORET, or directly to another Federal program, data was available from 95 percent of the agencies which had some toxic substances data. In those cases where data was available but filed in a manner which would require a large amount of the state agencies' time and resources to retrieve and copy that data, it was not acquired. In all such cases, the agencies stated that if OTS felt it were worth the time and expense, and provided the necessary resources, they would cooperate in making the data available. (Agencies with data which was not received during the project are listed and the data discussed in Volume III.)

2. In all cases where data was submitted, the agencies were agreeable to providing updating data if required in the future. The

only condition was that in many cases this would require some reimbursement for the costs of retrieval and copying.

3. Three state air quality agencies (14 percent of those monitoring some of the toxic substances) submit their data to SAROAD, and 14 of the water quality agencies contacted (58 percent) submit their data to STORET. An additional six public water supply agencies (38 percent of those with data) submit their data to STORET. A large portion of the state air and water toxic substances data is therefore currently available to OTS directly through EPA channels.

Overall Conclusions: Nature and Usefulness of State Data to OTS

1. One of the most important observations about the state toxic substances data is that virtually none of it was generated for the purpose of including it in a national data system and using it for detailed research and analysis. As concluded in the discussion of capabilities, states monitor a toxic substance for one of two reasons: either there has been a problem of contamination, or there is a requirement to monitor because of Federal and/or state regulations. In the former instance the monitoring is usually after-the-fact and source-directed. In the latter case, except where there may be a real or suspected local problem, monitoring is for the most part infrequent. As a general conclusion, state agencies, because of inherent limitations on how much they can do, monitor toxic substances only when, where, and as long as there is a real or

perceived threat to public health. Consequently the state data is of limited use for national trend analysis or establishing background levels of various substances across the nation.

2. With a few notable exceptions, state agencies contacted have not coordinated monitoring of toxic substances using the data from a number of environmental media to achieve a more complete appreciation of toxic substances problems. Air agencies check levels of a substance in the air, water agencies check it in water, agricultural agencies check it in food, etc., but only rarely is the information coordinated at the state level to assess total environmental threat and to pinpoint sources most requiring control. Two exceptions have been the comprehensive environmental monitoring of lead in El Paso and the similar coordinated study of arsenic in the Tacoma area. Without reference to potential sources and to ambient levels in other media, the state data is generally not very useful for comprehensive toxic substances analysis.

3. While it may be concluded that state agency use of standard analysis methods and laboratory quality control are strong points, other factors lessen the usefulness of state data for comparisons and aggregation for nationwide problem analysis. Chief among these factors are frequency of sampling, and number and location of sampling sites and samples. Frequency of sampling varied widely in all media for the toxic substances of interest. In air sampling, for example, one agency collects sample filters daily, several collect them for

analysis every sixth day, while others analyze monthly and quarterly composite samples. In water the range is from daily samples to one sample every two or three years. Similarly, the number of sites or samples ranges from several in some state agencies to several hundred in others. Before state toxic substances data can be of much use to OTS for analysis on a national level, standardization must go beyond laboratory methods and include frequency of sampling and number and distribution of sampling sites.

Conclusions: Arsenic

As the discussion of substances in Section 3 of this report indicates, arsenic is generally not regarded by the state agencies contacted as a significant environmental problem. The major exceptions to this conclusion are in specific, localized areas where ore smelting operations result in known arsenic emissions to the air and water, and adverse health effects are suspected in the vicinity. From the states contacted, these locations were El Paso, Texas; Tacoma, Washington; and Kellogg, Idaho. Additionally, there still remains some concern in agricultural states that lead arsenate spraying in past years may result in significant arsenic levels in foods. Environmental contamination of food with arsenic is found to be rare, however.

Conclusions: Beryllium

Beryllium was the least monitored of the toxic substances of interest and is not generally regarded as an environmental problem by

the 20 states. The only source-oriented monitoring was in Utah, where beryl ore is mined; and in Pennsylvania, where much of the ore is processed. Low ambient levels were reported in both states.

Conclusions: Cadmium

Cadmium is regarded as a potential environmental problem in all 20 states contacted. The toxic metal has been monitored in all media; and known or suspected sources include smelting operations, industrial/municipal effluents, leaching from ceramic utensils, and plant uptake from naturally-occurring cadmium.

Conclusions: Chromium

Chromium is considered a potential environmental problem by all states contacted, principally in waterways and drinking water supplies. Where some high levels were detected in waterways and sediments, the sources were believed to be industrial, especially plating industries. Chromium in the air was generally below detectable levels.

Conclusions: Cyanide

Cyanide is not generally believed to be a major environmental problem in the 20 states. Although it is monitored occasionally by most public water supply agencies, it remains the least monitored of the toxic substances of interest except for beryllium. Part of the difficulty of determining how much of a problem cyanide presents is that it is difficult to detect in chlorinated water. (chlorine destroys the cyanide ion in water.)

Conclusions: Lead

Lead shares with mercury the role of most monitored toxic substance in the most media. It is considered an environmental problem by agencies in all 20 states contacted. Lead is monitored in air, waterways, public water supplies, human blood, household paint and dust, soil, ceramic utensils, fish, wildlife, and food products. Despite the widely known effects of lead poisoning, it remains a major problem because the opportunities for exposure are so widespread in the environment.

Conclusions: Mercury

Because of nationwide public concern over the effects of exposure to mercury in the late 1960's and early 1970's, most of the agencies in all 20 states contacted have monitored the substance. It is now regarded as less an environmental threat than initially feared, but it is still monitored with regularity in areas where high levels have been reported in the past. Chief sources are believed to be industries, especially the chlor-alkalai industry, and residuals from fungicides with mercury compound constituents. While sources of mercury contamination are now thought to be well controlled, concentration of mercury in sediment and sludge from past releases are seen as a lingering problem by state agencies.

Conclusions: PCB's

Although all states contacted were aware of the potential hazards

of PCB contamination, PCB's were perceived as an environmental threat only in the states where they have been manufactured and/or where specific incidents of contamination have occurred. In the latter states; such as Georgia, North Carolina, Michigan and Massachusetts; PCB's are monitored fairly regularly in foods and water. In the remainder of the 20 states generally, the presence of PCB's is occasionally detected at low levels in the process of screening for chlorinated hydrocarbon pesticides.

Conclusion: Other Substances

While the other nine toxic substances of interest are recognized by the states as potential problems, many are now seen as highly localized and specialized problems and consequently are not routinely monitored by the agencies contacted. On the other hand, several agencies have run limited tests in recent months on some of the exotic organics of interest in water. These agencies felt that the organic substances may pose a greater hazard than the more commonly monitored metals, and they felt research and development of analytical methods in this area was needed from EPA.

RECOMMENDATIONS

Based upon contact with nearly 100 toxic substances monitoring agencies in 20 states and aquisition and analysis of most of their available data, it has been possible to summarize and to draw general conclusions as to the status of state agencies in monitoring toxic substances problems. Now, based on a knowledge of state agency capabilities and the availability, nature and usefulness of their data, recommendations can be made regarding how OTS should proceed vis-a-vis the state agencies and what use can be made of the accumulated data. Before proceeding with recommendations, it may be useful to summarize the conclusions regarding state capabilities and data, by listing the comparative advantages and disadvantages of state agency programs, as follows:

Advantages:	Disadvantages:
- In-depth knowledge of local problems	- Monitoring is problem-response, not systematic
- Quick response to immediate problems	- Little anticipation of future problems
- Base of trained people and equipment and networks available for integrated, systematic monitoring	- Little integration of monitoring among media and across jurisdictions now

With these characteristics of state toxic substances monitoring programs in mind, the principal recommendations follow.

1. Additional Data Acquisition.

Because the data acquired from the 20 states is believed to be representative of the non-Federal toxic substances data which is available, and because most of the data itself is not particularly useful for national trends or background analysis, it is recommended that additional historical data not be collected from the states at this time. However, analysis of the data collected and the assessment of state agency capabilities also indicates that there is a strong monitoring base available that is limited from more systematic monitoring primarily by lack of resources for more personnel and equipment. While most past state data may not be particularly useful for EPA's purposes, any plans for future expansion of toxic substances monitoring should take into account the existing base of state agencies which could be expanded to an effective, systematic monitoring network if funding is provided. It is therefore recommended that OTS survey the remaining 30 states to determine capabilities and availability of toxic substances data so that information will be available to EPA on which to base funding decisions for any future expansion of monitoring efforts.

2. Acquisition of Information on Federal Monitoring Activity

While the primary focus of this project was on acquisition of data from state agencies, it was learned in the course of the state meetings that a very considerable amount of environmental toxic sub-

stances data is being generated by Federal agencies such as USGS, USDA, FDA, Bureau of Sportfisherics and Wildlife, and others. Additionally, a number of other institutions are involved with toxic substances monitoring under Federal grants. It is recommended that OTS survey Federal and Federally-supported organizations to determine the nature and extent of their toxic substances monitoring capabilities, the nature and extent of the data available, and the most appropriate means of accessing the data.

3. Develop Information Clearinghouse Capability

It is recommended that OTS serve as the clearinghouse for promulgating information to state agencies on such matters as the latest standard methods of analysis, new analytical equipment developments, problems encountered and lessons learned in specific cases which may have wide application, and news of emerging toxic substances problems which states should be aware of. There is presently no such central focus of toxic substances information, and one clearly would be helpful to the state agencies.

4. Analyze Specific Problems in Depth

Since a broad, systematic approach to analyzing toxic substance problems across the nation does not seem possible with the type of data that is available from the states, it is recommended that OTS concern itself more with specific problems in the states rather than searching for overall trends. For each specific toxic substance, the available data can show where significant levels have

been encountered for certain media. Working with the Regional Offices and state agencies, OTS should perform a comprehensive analysis in those areas to determine sources, distribution of contamination, transport mechanisms, population at risk, documented health effects, control measures and eventual fate of the substance in the environment. This will mean in virtually every case the data available from the state agencies will have to be supplemented by additional monitoring and research. The end result will be a more complete understanding of the nature of the toxic substance as an environmental problem, with experience and knowledge that can be transferred to other areas with similar problems.

5. Early Warning of New Toxic Substances as Environmental Problems.

Toxic substances are generally monitored by state agencies only after their existence as an environmental problem has been well established. Furthermore, all state monitoring efforts are usually targeted at existing, known problems with no resources available for research into potential toxic substance problems. It is recommended that OTS fill this gap, through its own resources and those of other EPA offices where appropriate, by developing screening methods which will identify those substances most likely to become environmental problems in the future. In this way state agencies can have access to early warning on emerging toxic substances problems which their own resources could not provide.

6. Develop and Promulgate Standard Analysis Methods for Emerging Toxic Substances

Following logically from the above recommendation, methods will have to be developed for monitoring new substances in various media. Even if states had the resources to dedicate to methods development, there would be little value in having each laboratory develop its own method for each new substance. It is therefore recommended that OTS, with its own resources and those of other EPA offices where appropriate, develop standard methods and procedures for the analysis of all new environmental toxic substances, and promulgate these standards for use by all agencies in the states. As standard analysis methods are developed and promulgated, standards should be promulgated for the size and distribution of sampling networks and the frequency of sampling required to characterize a toxic substance problem adequately.

SECTION 1

OVERVIEW OF PROJECT RESULTS

Approach to the Project

In June of 1974 The MITRE Corporation contracted with OTS to collect and analyze post 1970 state monitoring data on specified toxic substances of interest. The final OTS list included the following 17 toxic substances.

arsenic	benzene
beryllium	3,3' dichlorobenzidine
cadmium	ethylene glycol
chromium	hydrazine
cyanide	methyl chloroform
lead	"Moco" (4,4' Methylene
mercury	2 Chloroanaline
polychlorinated biphenyls (PCB)'s	α napthylamine
aryl phosphates	acrylonitrile

OTS guidance regarding how much and what kind of toxic substances data and information MITRE should collect included the following:

- Water data submitted to STORET and air data submitted to SAROAD is available to OTS through EPA channels, so agencies should not be asked to resubmit such data to MITRE.
- The priority and emphasis of data collection should be on state agency data. Federal, university, and other data should be collected after the states have been contacted if contract resources allow.
- The data collection emphasis in the states should be on ambient data (i.e., levels of the substances detected in air, water, tissue, etc.).
- In addition to collecting and analyzing available data, it is important that information be obtained on the general monitoring capabilities of the agencies and supporting laboratories.

In the approach to the project, the contract required a two-phased effort. The first phase consisted of planning and testing

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out collection and analysis techniques in two states. From that experience, recommendations were made as to the best way to proceed with the second phase, which involved applying data collection and analysis procedures to as many of the remaining states as resources allowed. In summary, the data collection approach which was developed involved the following steps:

1. First, MITRE contacted the OTS liaison representative in each EPA Region to obtain information on the state agencies where the Regional Office is located, and to arrange a meeting with Regional program area representatives to obtain information on monitoring programs of all states in the Region.
2. With information supplied by the OTS liason representative, and information from available directories,[1,2,3] all agencies which might monitor toxic substances in the states where the Regional Offices are located were contacted by telephone. Meetings were scheduled with the officials of those agencies which indicated they had data, to follow the visit to the EPA Regional Offices.

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[1] Directory of State Agencies Engaged in Environmental Monitoring, E.P.A. (Office of Research and Development), December 1973.

[2] Governmental Air Pollution Agencies, Air Pollution Control Association, October 1973.

[3] Environment U.S.A.: A Guide to Agencies, People, and Resources, R.R. Bowker Co., 1974.

3. MITRE representatives met at the Regional Offices with program representatives to obtain information on points-of-contact and monitoring activity in all the states of the Region.

4. Following the Regional Office meetings, MITRE representatives met with the agencies in the states where the Regional Offices are located to acquire all available toxic substances data and to evaluate laboratory capabilities.

5. When all ten Regions and one state in each Region had been visited, MITRE reviewed the information on state agency programs and selected a priority listing of the remaining states to be visited, using as criteria the following:

   - amount of toxic substances data available
   - seriousness of toxic substances problems
   - east and west coast mix
   - coastal and inland mix
   - industrial and rural mix

The point of balancing the states in this manner was to ensure that a representative mix of states would be contacted if it were not possible to visit all states. Agencies in a total of 20 states were contacted in the course of the project. Figure 1 shows the states visited.

In formulating a general plan for processing, summarizing, and analyzing the state data, a great deal of flexibility had to be maintained. The experience of Phase 1 showed that the state agencies monitor many of the toxic substances in a wide variety of media at

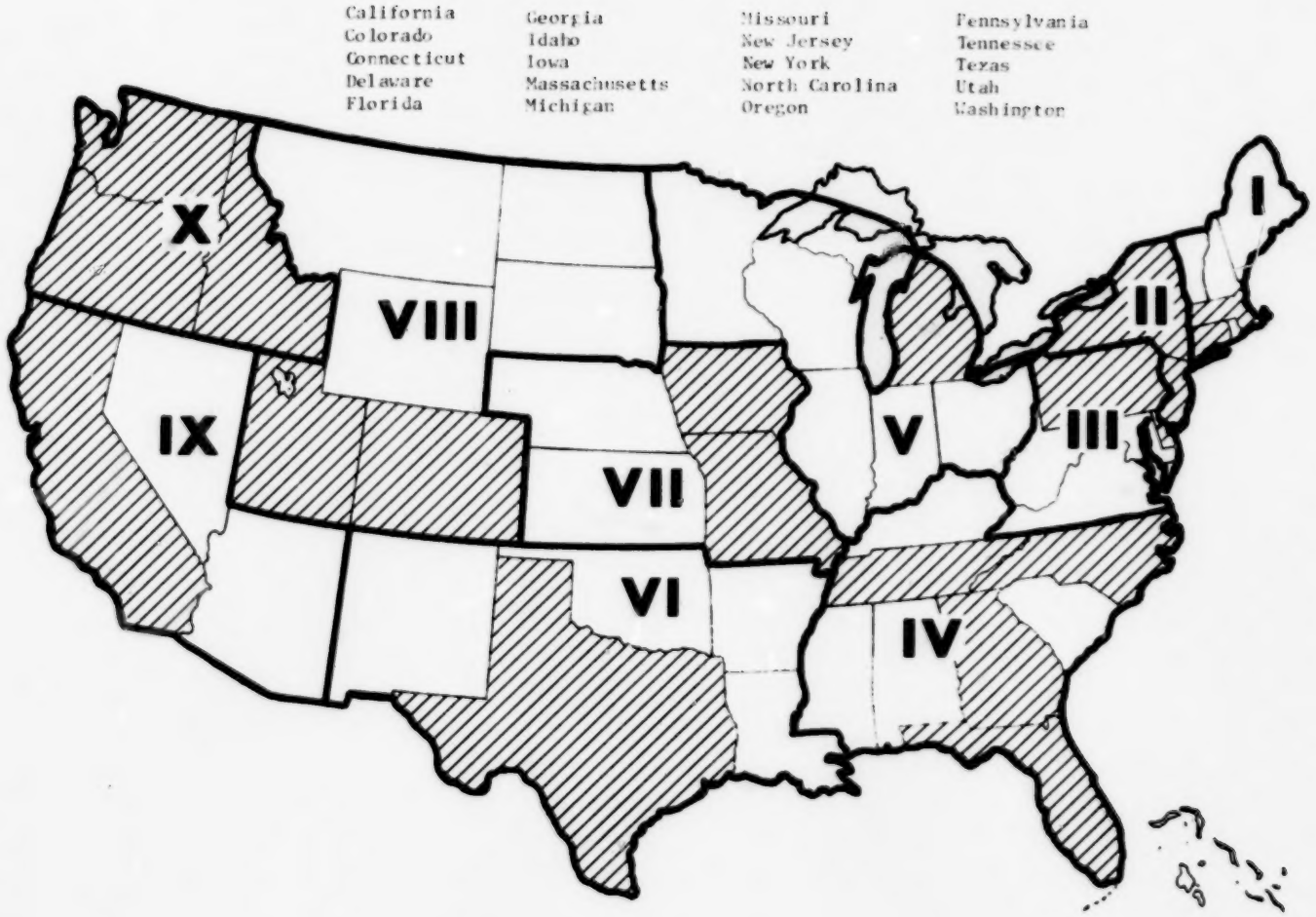

FIGURE 1
STATES AND EPA REGIONS CONTACTED DURING THE TOXIC SUBSTANCES PROJECT

widely differing frequencies, and that rarely was anything resembling a standard data format used except where the data was reported to SAROAD or STORET. The data analysis plan which evolved called for the following procedures:

1. MITRE processed the state air quality data into SAROAD-compatible format; and summarized and analyzed for range of observations, mean, and standard deviation by sampling station, by toxic substance, and by year.
2. Where appropriate, MITRE processed water quality and water supply data into a STORET-compatible format; and summarized and analyzed for range of observations, mean, and standard deviation by sampling station, by toxic substance, and by year.
3. For the remainder of the data, which included levels of toxic substances in hair, blood, fish and animal tissue, paint, food, feeds, plants, soil, dust, and sludge; MITRE processed the particular data to whatever reasonably standard format it was amenable to; and summarized and analyzed it as its unique characteristics allowed.

The plans for data collection and analysis were carried out through contacts with environmental, health, and other related agencies in the 20 states. The types of agencies providing data included those with responsibility in the area of air pollution, water pollution, solid waste, drinking water, fish and wildlife,

sanitation, agriculture, natural resources, geology, food and drug, and public health. So that useful summaries and analyses could be made of the type and amount of toxic substances monitoring in the states, the various agencies were aggregated into the media or program area categories for air, water, solid waste, human health, fish and wildlife, and agriculture. In the four quarterly reports which were submitted to OTS to review the progress on the project, results of all contacts with the state agencies were summarized in terms of those categories. More complete details of data acquisition meetings were contained in the main texts of the quarterly reports, as were complete summaries and analyses of the data obtained according to the data analysis plan.

Clearly, with the focus of the project on state environmental toxic substances data, a large amount of the total information available on toxic substances from other sources was not collected and analyzed for this project. Figure 2 illustrates the fraction of toxic substances data collected for this project and its relationship to the total amount of information and data available.

As described in the introduction, the objectives of assembling a toxic substances data base and presenting results of data summaries and analyses are addressed in Volume III and Volume IV respectively. The two remaining objectives -- describing toxic substances monitoring capabilities and analyzing the availability, nature and usefulness of the data to EPA -- are addressed in this volume, with reference

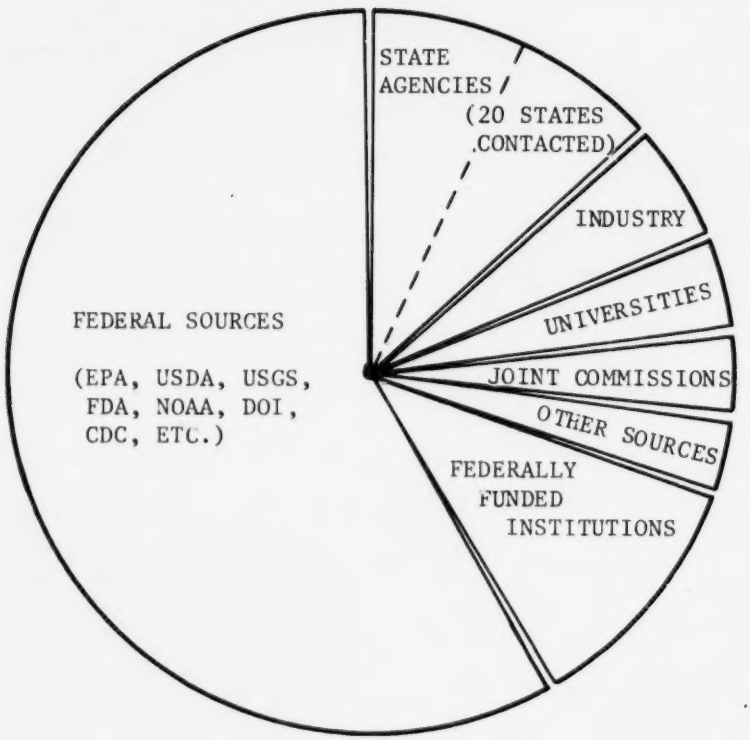

FIGURE 2
TOTAL TOXIC SUBSTANCES DATA AVAILABLE
(For illustration only—proportions estimated)

to the information contained in Volumes II through V.

Overview of Monitoring Capabilities

In order to provide some quantitative measure of state toxic substances monitoring capabilities, MITRE identified 25 key monitoring program descriptors and asked each agency to provide information on them. Responses from each agency were recorded on a table, by state and toxic substance, similar to that shown in Figure 3. Table 2 is a key to the codes which were used in completing the forms. When these sheets were completed for all 20 states and all of the eight toxic substances for which data was available (a total of 160 tables in all), the matrices were summed and analyzed for each of the descriptors by state, program, and type of agency. Highlights of that analysis are contained in this overview section, and a more complete description of results by toxic substance is found in the section describing state agency capabilities.

Table 3 presents the overall summary of toxic substances monitoring capabilities of the 95 agencies in 20 states contacted in the course of this project. The table was developed from analysis of information recorded on the 160 monitoring program descriptor tables, one for each state and for each substance, found in Volume V of this final report. This summary discussion is keyed to the information contained in Table 3.

1. Total Sites. The data received represented over 25,000 sites in the 20 states. As the chart shows, the overwhelming

STATE	MEDIA/PROGRAM AREA																
	AIR				WATER					SOLID WASTE		HUMAN HEALTH		FISH AND WILDLIFE		AGRI-CULTURE	OTHER
TOXIC SUBSTANCE	AGENCY																
	1.	2.	3.	4.	1.	2.	3.	4.	5.	1.	2.	1.	2.	1.	2.	1.	1.
MEDIA SAMPLED[1]																	
NO. OF SITES																	
SAMPLING FREQUENCY																	
EST. OBSERVATIONS PER YR.																	
INCLUSIVE DATES OF DATA																	
AMBIENT LEVELS[2]																	
MONITORING OBJECTIVE[3]																	
DATA STORAGE FORM[4]																	
DATA RECORDING LAG																	
ANALYSIS PERFORMED[5]																	
DATA RETENTION PERIOD																	
SAMPLE RETENTION PERIOD																	
DATA IN FED. SYSTEM																	
AVAILABILITY OF UPDATES																	
LAB USED[6]																	
NO. OF LAB PERSONNEL																	
NO. OF DEGREED CHEMISTS																	
FORMAL LAB TRAINING PROGRAM																	
MAJOR EQUIPMENT																	
METHOD OF ANALYSIS																	
QUALITY CONTROL PROCEDURES[7]																	
OTHER T.S. MON. CAPABILITY																	
FUTURE FOCUS OF MONITORING[8]																	
ASSISTANCE DESIRED FROM EPA[9]																	
OTHER COMMENT																	

NOTE: Footnotes refer to the key to the codes, Table 1.

FIGURE 3
CAPABILITIES DESCRIPTOR FORM

TABLE 2

KEY TO CODES USED ON STATE MONITORING PROGRAM CAPABILITIES DESCRIPTOR FORMS

N. A. = Not Applicable

N. O. = Information not obtained

1. Media Sampled:

A = Air, dust
W = Surface and groundwater
D = Drinking water
F = Food and consumer products
T = Animal tissue
B = Human blood, etc.

2. Ambient Levels:

Page number refers to page in Volume IV where statistics may be found

3. Monitoring Objective:

C/E = Compliance/Enforcement
RP = Routine population oriented
RB = Routine background
S = Scientific research

4. Data Storage Form:

C = Computerized
S = Report sheets
R = Periodic compiled report

5. Analysis Performed:

O = None
C = Screened for compliance
S = Basic statistics analysis
D = Detailed study

TABLE 2 (continued)

KEY TO CODES USED ON STATE MONITORING PROGRAM CAPABILITIES DESCRIPTOR FORMS

6. Lab Use:

A = Controlled by agency
S = Shared with other agency(ies)
C = Contract lab
U = University lab

7. Quality Control Procedures:

I = Internal (standards, replicate)
C = Check samples with other labs
NP = No quality control program

8. Future Focus of Monitoring:

IS = Increase substances monitored
IN = Increase sampling network and/or number of samples
S = Continue at about present level
DS = Decrease substances samples
DN = Decrease network size and/or number of samples

9. Assistance Desired from EPA:

$ = Funds for more manpower and/or equipment

S = Develop and promulgate standard analysis methods for all toxic substances

T = Funded EPA training programs

O = Other

TABLE 3
OVERALL SUMMARY OF MONITORING FOR TOXIC SUBSTANCES IN 20 STATES

	PROGRAM AREA						
PROGRAM DESCRIPTOR	AIR	WATER SUPPLY	WATER QUALITY	SOLID WASTE	HUMAN HEALTH	FISH & WILDLIFE	AGRI-CULTURE
1. TOTAL SITES	388	15,612	9,272	30	N.A.	57	N.A.
2. TOTAL OBSERVATIONS PER YEAR	44,906	103,114	256,762	600	12,840	45,174	63,633
3. PERCENT DATA RECEIVED	91	81	92	100	89	88	75
4. MONITORING OBJECTIVE	BACKGROUND	POPULATION	COMPLIANCE	COMPLIANCE	POPULATION	BACKGROUND	POPULATION
5. STORAGE FORM	DATA SHEET	DATA SHEET	COMPUTER	COMPUTER	DATA SHEET	DATA SHEET	DATA SHEET
6. USE OF DATA	STATISTICS	STATISTICS	STATISTICS	STATISTICS	SUPPLIES/ CHECKED	STATISTICS	CHECKED
7. DATA RETENTION TIME	10+YRS	10+YRS	10+YRS	5+YRS	10+YRS	10+YRS	10+YRS
8. SAMPLE RETENTION TIME	10+YRS	- 0 -	- 0 -	- 0 -	VAR.	- 0 -	- 0 -
9. STORET/SAROAD	4 of 22	6 of 16	16 of 25	N.A.	N.A.	N.A.	N.A.
10. LAB TYPE	OWN LAB	OWN LAB	OWN LAB	CONTRACTED	OWN LAB	OWN CONTRACT	OWN LAB
11. AVG. NO. LAB PERSONNEL/ CHEMISTS	17/7	18/11	17/11	105/30	78/38	26/19	28/15
12. TYPE TRAINING	OJT +	OJT +	OJT +	OJT +	OJT +	OJT +	OJT +
13. LABS WITH GC & AA	12 of 22	14 of 16	22 of 24	2 of 2	7 of 9	6 of 8	11 of 11
14. CAN DO ADDITIONAL TOXIC SUBSTANCES	16 of 22	13 of 16	22 of 24	2 of 2	8 of 9	6 of 8	11 of 11
15. ANALYSIS METHOD	EPA	APHA	EPA	EPA	FDA	APHA	AOAC
16. QUALITY CONTROL	INT./EXT.	INT./EXT.	INT./EXT.	INT./EXT.	INT./EXT.	INT./EXT.	INT./EXT.
17. FUTURE MONITORING FOCUS	VAR.	VAR.	VAR.	MORE T.S.	VAR.	VAR.	REMAINS SAME
18. HELP DESIRED	STDS., $	$, OTHER	$	$	$, STDS.	$	STDS.

preponderence of sites were in water monitoring. No sites are shown for the areas of human health and agriculture because in those areas samples were taken of such materials as blood and food and specific sampling stations were not usually involved.

2. Total Observations/Year. Including all monitoring in all media, there are 550,000 samples analyzed for toxic substances each year by agencies in the 20 states contacted. The chart shows the breakdown of sampling by program areas.

3. Percent Data Received. This line shows agencies from whom data was received as a percent of total number of agencies contacted. The overall figure for all agencies was 95 percent. For this summation, data in SAROAD and STORET or otherwise submitted directly to Federal agencies was considered data received. As explained in Volume III for each specific agency, the reasons data wasn't received from some agencies were either that the data was in the process of being compiled, or that the data could not be readily compiled without a considerable effort on the part of the agency.

4. Monitoring Objective. Agencies were asked if their main monitoring objective was compliance/enforcement oriented, population oriented, (i.e., checked for levels which may endanger human health), or background oriented. Many responses showed combined objectives, but the prevalent overall response was population oriented. No agency monitored purely for research purposes.

5. Storage Form. The entries here concern form of data records and are either report sheets, compiled periodic reports, or computerized storage. As the chart shows, the common data storage form is filed report sheets, except for water quality (where much of the data is in the STORET system) and solid waste (where only two agencies

contacted have toxic substances data), which were mostly computerized.

6. Use of Data. This line describes what is done with the data once it is generated. The entries were checking for compliance with standards, basic statistics, and detailed studies. The most common use of the data was in basic statistical summaries, except the areas of human health and agriculture where the data was checked for compliance with standards only.

7. Data Retention Time. The majority of agencies in all media maintain historical records of their data for at least 10 years.

8. Sample Retention Time. Because of the different nature of samples in different media, retention time varies from zero to at least 10 years. In the majority of cases, portions of air sample filters are retained by air quality agencies at least 10 years. Food, water, blood, and other samples are generally not retained after analysis unless they show levels in excess of standards, and in those cases samples are retained where possible until appropriate action is taken and the case disposed of.

9. Data in STORET/SAROAD. This line refers to the two major EPA data storage systems for water and air respectively. As shown, three of 22 air agencies submit toxic substances data to SAROAD (although this is not as yet a requirement), six of 16 water supply agencies submit data to STORET, and 14 of the 24 water quality agencies submit data to STORET.

10. Lab. Type. Laboratories used by the various state agencies were either controlled by the agencies, shared facilities with other agencies, outside contracted laboratories, university laboratories, or various combinations. For most of the program areas, the majority of agencies used their own laboratories. The two solid waste agencies doing toxic substances analysis contracted with other laboratories, and the fish and wildlife agencies were split between those that had their own laboratories and those which contracted for analysis.

11. Avg. No. Lab. Personnel/Chemists. This line shows the average number of people working in the laboratories by program area and the average number of those that are degreed chemists. For some categories, personnel with degrees in a related field and strong backgrounds in chemistry were counted as degreed chemists. The overall average for all laboratories in the 20 states was 38 personnel, 16 of whom were degreed chemists, for an average ratio of one chemist per 2.5 total personnel.

12. Type Training. For the majority of agencies in all areas, the prevalent type of training was on-the-job-training (OJT), supplemented in a number of cases by occasional outside training courses when resources allowed. No full-scale, formal training programs were reported.

13. Labs with GC and AA. Possession of gas chromatograph and atomic absorption equipment appears to be one indicator of

the capability of agencies to monitor all the toxic substances of interest. In virtually every agency, atomic absorption equipment was available, and in most areas except air and water supply, the majority of laboratories had both atomic absorption and gas chromatograph equipment.

14. Can Do Additional Toxic Substances. Agencies were asked if they felt they had the equipment and personnel capabilities for monitoring additional toxic substances if there was a requirement to do so. A large majority of agencies responded that they could monitor most toxic substances on the OTS list if an acceptable method of analysis were available.

15. Analysis Method. All but five laboratories reported that they employed the standard analytical method appropriate to the type of analysis done. These included standard methods recommended by EPA, the American Public Health Association, the Association of Official Analytical Chemists, the USDA, and FDA. Where EPA has recommended a standard method, the majority of agencies reported that that is the method they use. The other five agencies used manufacturers' recommendations for the type of analytical equipment used, or they have developed their own methods.

16. Quality Control. The prevalent type of quality control procedures in effect in the majority of agencies includes both internal checks with standards and duplicate samples; and some outside, interlaboratory checking of samples with Federal and other laboratories.

17. Future Monitoring Focus. There was a division in most areas as to whether the future focus of monitoring would result in increasing the network size and number of samples analyzed, increasing the number of substances monitored, or remaining at about the same level.

18. Help Desired. When asked what assistance from EPA would be most helpful in carrying out their toxic substances programs, the majority of agencies responded that the two most needed items were: development and promulgation of standards for acceptable levels in the environment and for methods of analysis; and funding support for laboratory equipment and personnel.

A more detailed discussion of agency capabilities is found in the section Description of State Toxic Substances Monitoring Capabilities. The format of Table 3 will be followed there in describing state toxic substances monitoring capabilities with regard to each toxic substance monitored.

Overview of State Toxic Substances Problems

As is evident from the MITRE summaries and analyses of state agency data presented in Volume IV, state toxic substances data has been collected by a variety of agencies within states, for a number of reasons, in many media, at different sampling frequencies, from a variable number of sites, for different lengths of time. In general, where significant levels of a substance are determined, the monitoring has been source-specific; and where more widespread monitoring is done because of administrative requirements rather than because of a problem, sampling is infrequent and values are consistently low. Consequently, a quantitative aggregation and analysis of data from the 20 states contacted would not be very meaningful. However, based on the summaries and analyses of data and on discussions with officials in the states, it is useful to present a narrative discussion of the environmental problems associated with each of the toxic substances of interest as perceived by agencies in the 20 states. A more detailed discussion of each substance is presented in Section 3, Toxic Substance Problems as Perceived by State Agencies. The following is a summary of the Section 3 discussion.

Arsenic

Arsenic is a well known toxic element whose compounds have widespread use in agriculture and industry. All 20 states monitor water supplies and none except Iowa report any substantial problem. In the case of Iowa raw surface water supplies were found to have exceeded the 0.05 ppm US PHS limit, but, after treatment for the removal of iron, the level usually dropped well below that value.

The most prominent case of arsenic pollution and hazard was reported in Tacoma, Washington, where the largest production of the metal in this hemisphere occurs. Studies have been conducted by state agencies and their preliminary results linked stack emissions to illnesses and high household levels of arsenic. El Paso, Texas has also reported high arsenic concentrations in Hi-Vol samples tested to determine the levels of lead and other trace metals present.

The agricultural food laboratories in ten states test routinely for arsenic and five states include arsenic in their trace metal air programs.

Outside of the areas of specific source emissions, arsenic is not viewed by the state agencies contacted as an environmental problem. Table 4 shows a summary of arsenic monitoring among the 20 states.

Beryllium

Beryllium is the least monitored of the toxic substance under review. Its toxicity is recognized by state officials but they feel its main threat to health occurs in the workplace. A Beryllium

TABLE 4

ARSENIC MONITORING SUMMARY

REGION & STATE	MEDIA					
	AIR	WATER	SOLID WASTE	HUMAN HEALTH	FISH & GAME	AGRICULTURE
I CONN.		•				•
I MASS.		•				
II N.J.		•				
II N.Y.	•	•	•			•
III DEL.		•				
III PA.	•	•				•
IV FLA.		•				
IV GA.		•				•
IV N.C.		•				•
IV TENN.	•	•				•
V MICH.	•	•				•
VI TEX.	•	•		•		
VII IOWA		•				
VII MO.		•				
VIII COLO.		•		•		
VIII UTAH		•		•		•
IX CAL.		•			•	•
X IDAHO		•				
X OREG.		•				•
X WASH.	•	•		•		

• = Fairly routine monitoring, more than one-time survey.

Registry is maintained by the Massachusetts General Hospital and discussions with the staff reveal that over 99 percent of more than 800 cases reported over the years were work-related incidents.

None of the states has reported any current problem in any area of the environment resulting from beryllium contamination. It is mined in Utah (the only such operation in the US) and air monitoring stations reportedly show low levels there. Data from this surveillance was not immediately available to MITRE. Pennsylvania, which is a prime area of processing the ore, monitors air and water for the metal but has not reported any significant levels. Additional background monitoring in air occurs in Connecticut, New York, Tennessee, and Michigan. It is also monitored in water in New York as a part of the heavy metals program in cooperation with the USGS, but was not detected in significant concentrations.

In spite of the wide industrial use of beryllium and its compounds, it was not considered by the state agencies contacted to be a problem in the ambient environment in any media. Table 5 shows the monitoring of beryllium in the States.

Cadmium

Cadmium, widely recognized as a toxic substance with suspected carcinogenic properties, has varied application in industries throughout the nation. It was one of the substances most extensively monitored by the 20 states. All states monitor their water supplies for cadmium content and 17 monitor their wastewater discharges.

TABLE 5

BERYLLIUM MONITORING SUMMARY

REGION & STATE	MEDIA					
	AIR	WATER	SOLID WASTE	HUMAN HEALTH	FISH & GAME	AGRICULTURE
I CONN.	•					•
I MASS.						
II N.J.						
II N.Y.	•	•				
III DEL.						
III PA.	•	•				
IV FLA.						
IV GA.						
IV N.C.						
IV TENN.	•					
V MICH	•					
VI TEX.						
VII IOWA						
VII MO.						
VIII COLO.						
VIII UTAH	•					
IX CAL.						
X IDAHO						
X OREG.						
X WASH.						

• = Fairly routine monitoring, more than one-time survey

However, cadmium has not been reported by the states as a problem in public water supplies.

Cadmium was reported in California in high levels in areas which were used for the cultivation of spinach and other crops. It was traced to naturally occuring deposits in phosphatic rocks which had weathered and eroded into the Salinas Valley. Spinach and other leafy crops were found to have an affinity for cadmium which was concentrated in far greater levels than the surrounding soil showed. This discovery occurred during 1970 and forced the temporary discontinuation of spinach farming in that area of the state.

Agency officials felt other sources of high cadmium levels were from lead and arsenic smelters in El Paso, Texas; and Tacoma, Washington. Hi-Vol samples from the vicinity of the smelter in El Paso showed high concentrations of cadmium. Lead, which was emitted in greater concentrations than cadmium, was believed to be the source of illnesses in the area. Large volumes of data have been collected by the El Paso Health Department and most of it was obtained by MITRE. Air, soil and dust have been analyzed and the analysis is included in Volume IV. In Tacoma, Washington, less data was available, but indications from state health officials were that high levels of cadmium were also emitted from the smelter.

The other states monitored for cadmium as a part of their programs to determine background levels for heavy metals. There

were no reports of elevated levels in any medium other than seafood and sediments. Samples from such areas showed the presence of the metal resulting, according to state agencies, as a fallout from industrial wastes. These levels were not found in any substantial concentration.

Outside of California and the environs of the smelters, cadmium was not reported by the states contacted as an environmental problem. Table 6 illustrates a summary of cadmium monitoring in the states.

Chromium

All of the states contacted are concerned about the toxicity of hexavalent chromium. Many states monitor for both hexavalent and total chromium, while some test only for total chromium. Chromium is monitored in drinking water supplies in 15 of the 20 states, and other states monitor the chromium content of wastewater discharged to streams. Chromium has not been reported by the 20 states as a problem in water supplies. However, some states have reported concern over probable discharge of chromium waste to streams. For example, Florida reported the unconfirmed belief that chromium salts are used in air conditioning systems as anticorrosive agents and are discharged to surface waters.

Five of the 20 states monitor chromium in their air network routinely and none have noted any problem area. Five states have included the metal in fish surveys and two have been routinely checking solid waste leachate for it. Three states report that they check for chromium in agricultural products regularly.

TABLE 6

CADMIUM MONITORING SUMMARY

REGION & STATE	MEDIA					
	AIR	WATER	SOLID WASTE	HUMAN HEALTH	FISH & GAME	AGRICULTURE
I CONN.	•	•			•	•
I MASS.		•			•	
II N.J.		•			•	
II N.Y.		•	•			•
III DEL.	•	•				
III PA.	•	•				•
IV FLA.		•				
IV GA.		•				
IV N.C.		•		•		•
IV TENN.	•	•				
V MICH.	•	•				
VI TEX.	•	•		•		
VII IOWA		•				
VII MO.	•	•				
VIII COLO.	•	•		•	•	•
VIII UTAH		•				
IX CAL.	•	•			•	•
X IDAHO	•	•				
X OREG.		•				
X WASH.	•	•		•		

• = Fairly routine monitoring, more than one-time survey

The emphasis in chromium monitoring, as can be seen from Table 7, is in water. It continues to have a high priority in all 20 states and will undoubtedly remain on the list of heavy metals monitored.

Cyanide

The 20 states contacted did very little monitoring of cyanide. Although it is well recognized as a lethal substance, state agencies were aware of no health hazard from environmental sources. The low level of monitoring activity might also be related to the instability of the substance and hence the difficulty of detecting it. It is destroyed by chlorine and other oxidizing substances and therefore its detection in drinking water would be rendered difficult, if not impossible, since such water usually carries a residue of chlorine. Nevertheless, ten of the states monitor water supplies routinely for cyanide. The only other monitoring occurs in one state where solid waste leachate is tested, and in two states where it is monitored in agricultural products. Table 8 shows the monitoring of cyanide amoung the 20 states.

Lead

Lead is the most widely monitored of all the toxic substances being considered. All 20 states monitor it in water and all but four monitor it in air routinely. Those that do not have ongoing programs have generally done preliminary investigations in the past, and are planning to start regular programs. In addition, several monitor it in human blood, in fish and game, and in agriculture. Table 9

TABLE 7

CHROMIUM MONITORING SUMMARY

REGION & STATE	MEDIA					
	AIR	WATER	SOLID WASTE	HUMAN HEALTH	FISH & GAME	AGRICULTURE
I CONN.	•	•	•		•	•
I MASS.		•			•	
II N.J.		•			•	
II N.Y.		•	•			•
III DEL.	•	•				
III PA.		•				
IV FLA.		•				
IV GA.		•				
IV N.C.		•				
IV TENN.	•	•				
V MICH.		•				
VI TEX.	•	•				
VII IOWA		•				
VII MO.	•	•				
VIII COLO.		•				
VIII UTAH		•				
IX CAL.		•			•	•
X IDAHO		•				
X OREG.		•				
X WASH.		•				

• = Fairly routine monitoring, more than one-time survey

TABLE 8

CYANIDE MONITORING SUMMARY

REGION & STATE	MEDIA					
	AIR	WATER	SOLID WASTE	[illegible]H	FISH & GAME	AGRICULTURE
I CONN.			•			•
I MASS.						
II N.J.						
II N.Y.		•				
III DEL.						
III PA.						
IV FLA.		•				
IV GA.		•				
IV N.C.		•				
IV TENN.		•				
V MICH.						
VI TEX.						
VII IOWA						
VII MO.		•				
VIII COLO.		•				
VIII UTAH		•				
IX CAL.		•				•
X IDAHO						
X OREG.		•				
X WASH.						

• = Fairly routine monitoring program, more than one-time sampling

TABLE 9

LEAD MONITORING SUMMARY

REGION & STATE	MEDIA					
	AIR	WATER	SOLID WASTE	HUMAN HEALTH	FISH & GAME	AGRICULTURE
I CONN.	•	•		•	•	•
I MASS.		•			•	
II N.J.		•			•	
II N.Y.	•	•	•	•		•
III DEL.	•	•				
III PA.	•	•				•
IV FLA.	•	•		•		
IV GA.	•	•				•
IV N.C.		•		•		•
IV TENN.	•	•				•
V MICH.	•	•		•		
VI TEX.	•	•		•		
VII IOWA		•				
VII MO.	•	•				
VIII COLO.	•	•		•	•	
VIII UTAH		•		•		•
IX CAL.	•	•			•	•
X IDAHO	•	•				
X OREG.	•	•				•
X WASH.	•	•		•		

• = Fairly routine monitoring, more than one-time sampling

shows the extent of the monitoring activities among the states.

The presence of lead in air is widespread throughout the nation partly because of its use in gasoline, but more serious incidents of airborne lead pollution concerned the emissions from the stacks of metal smelters. The most outstanding case was reported in El Paso, Texas where city/county officials obtained a court injunction which barred the smelting company from future emissions of dangerous levels of toxic substances by 1977. Epidemiological studies had correlated illness of residents of immediate areas of the smelter with elevated levels of lead in their system. Similar concern over lead contamination was also reported from Tacoma, Washington, and Kellogg, Idaho, where smelters are also operated. Studies were continuing in both locations and reports should be available soon. The Texas and Washington health agencies have reported some degree of cooperation with operators of the smelters in instituting controls on stacks to reduce levels of emissions of particulate matter.

Many states are engaged in studies with children to detect elevated levels of lead in the blood so that treatment can be effected. These programs arise from the problem of pica* in neighborhoods with old housing which usually has leaded paint. These programs are usually sponsored by and coordinated with the Center for Disease Control (CDC) in Atlanta, Georgia.

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*The habit of young children ingesting strange objects such as dirt and paint chips.

Lead is usually among the heavy metals monitored in water supplies. None of the states report any significant problems with lead in water supplies. The data generally reveal very low levels or values below levels of detection.

Many states have determined lead in pottery and other household wares. Such determinations are usually sporadic and are done on the request of private individuals who might suspect lead contamination. The vast majority of the tests performed in the states do not show any lead, and the number of these kinds of samples have diminished considerably from a peak in the early 1970's. California officials indicated that a bill was recently enacted to monitor the movement of foreign pottery which is believed to be the major source of utensil lead.

Because of the use of lead in the canning industries as a component of solder, occasional contamination might be evidenced. However, none of the states reported any significant recent incidents, and discussions with officials of the National Canners Association have indicated that close, stringent quality control measures are observed to prevent possible contamination.

Although all 20 states seem to be wary of the toxic potential of lead, only those with metal smelting and refining operations or problems with lead-based paint in older dwellings have indicated significant environmental health problems of lead poisoning.

Mercury

Mercury is well known to the environmental agencies in the 20

states contacted as a potentially hazardous substance. Probably because of the publicity which followed from the reported illnesses and deaths in Japan in the late 1960's, all the states have monitored mercury in at least one medium. The predominant emphasis was on surveys in water and fish and wildlife. Most of these started in about 1969 and were discontinued after several years or were reduced in scale to intermittent monitoring.

Much historical data is available from most states, although only a few states have compiled and analyzed their data. One of the major mercury surveys occurred in Massachusetts where there was substantial pollution from industrial sources, and subsequent contamination of fish. In Georgia, Texas, and Idaho, mercury pollution was a major problem in the fishing and hunting areas. Fishing areas were closed and residents were cautioned about excessive consumption of fish and birds from some locations. The results from the fish surveys generally showed that larger and older fish had more mercury than smaller and younger ones of the same species. The predominant source of mercury in Georgia was identified by state officials as a chlor-alkali plant, while in Texas and Idaho the sources were believed by the agencies to be industrial wastes and the drainage from natural deposits. Pheasants in Idaho, according to the state agency, became contaminated from eating mercury-treated grains planted during the spring. The use of mercury was discontinued in the industrial processes implicated in Massachusetts, while Georgia and Texas agencies reported that the concentration of

mercury in wastes has decreased substantially. All of the remaining states except Missouri and Utah also reported surveys over a three to five-year period, but none revealed findings of similar magnitudes as those mentioned above.

At about the same time as the fish surveys, many states also monitored water systems for mercury. All 20 states did some testing for mercury. The levels reported in water quality data were at or below limits of detection. The only exception was in Massachusetts where surface and ground water in the immediate area of specific waste disposal and discharge was found to have very high levels of mercury. This water system was not identified as a source of potable water supply.

The data available in the 20 states substantiate the statements made by the states that mercury is not as widespread a problem as initially believed, at least in their water supplies. No state reported any current case of contamination in any area where fishing or hunting had to be restricted or prohibited, and most have expressed confidence in the acceptable quality of their fish and game. Furthermore, none of the 20 states identified any case of human mercury poisoning or associated illness. Table 10 illustrates the extent of mercury monitoring among the 20 states.

PCB's

Because of the physical and chemical similarities of PCB's to DDT and other chlorinated hydrocarbons, there is a strong awareness of potential PCB problems among the environmental agencies in the 20 states

TABLE 10

MERCURY MONITORING SUMMARY

REGION & STATE	MEDIA					
	AIR	WATER	SOLID WASTE	HUMAN HEALTH	FISH & GAME	AGRICULTURE
I CONN.		•	•	•	•	
I MASS.		•	•	•	•	
II N.J.		•			•	
II N.Y.		•	•		•	•
III DEL.		•	•		•	
III PA.		•			•	
IV FLA.		•	•		•	•
IV GA.		•			•	
IV N.C.		•			•	
IV TENN.		•			•	
V MICH.	•	•		•	•	•
VI TEX.	•	•			•	
VII IOWA		•			•	•
VII MO.		•				
VIII COLO.		•			•	
VIII UTAH		•		•		
IX CAL.		•		•	•	•
X IDAHO		•		•	•	•
X OREG.		•			•	•
X WASH.		•			•	

• = Fairly routine monitoring, more than one-time surveys.

contacted. Only Colorado and Missouri did not report any monitoring activity for PCB's in any medium.

According to agencies in Massachusetts and Georgia there was a significant pollution of surface waters and the biota which inhabit them. In both states the sources of PCB's were believed by agency officials to be from electrical component manufacturing operations which contaminated the streams. Iowa has reported a localized case of PCB contamination of two species of rough fish. Florida reported an earlier incident in Escambia Bay which was probably the first known case of fish contamination by PCB's in the United States. The Florida incident was traced by the state agency to leakage from the PCB storage facilities at the producer's plant. California and New York have also done fish surveys on a sporadic basis but did not report any significant findings. Eight of the states -- Connecticut, New York, Pennsylvania, North Carolina, Tennessee, Michigan, Utah, and Oregon -- routinely monitor agricultural products for PCB's as a part of pesticide residue monitoring. When PCB's are detected in preliminary tests these states have the capability to quantify the level of the substance present. A major agricultural episode of PCB contamination occurred in a number of the southern states including Georgia, North Carolina, and Tennessee. This incident involved the death of a large number of chickens, and resulted in an extensive survey that found massive contamination in a wide range of agricultural products, silage, and compost.

States generally did not have consistent programs of routine

monitoring of water supplies for PCB's. Several of the states have checked surface water and groundwater at some time in the past and those that have done fish surveys usually analyzed water samples. Most of the water supply laboratories do not have the capability for analyzing PCB's now, but most states have expressed the view that the implementation of the Safe Drinking Water Act will result in an increase in agency capability for its routine determination along with other organic chemicals.

While all the states seem to be fully aware of the potential for adverse effects from PCB's, only the pesticide residue laboratories and a few fish and wildlife agencies have evolved any significant programs to monitor them. This will probably change in the near future with the increased interest in organic chemicals and the recently reported findings (at the time of writing this report) of abnormally high levels in commercial fish in the state of New York. Table 11 illustrates the extent of PCB's monitoring in the states.

Other Toxic Substances

There were nine other toxic substances on the list of those of interest to OTS. These were: aryl phosphates; benzene; 3,3' dichlorobenzidine; ethylene glycol; hydrazine; methyl chloroform; "Moca" (4,4' methylene bis 2 chloroanaline); α napthylamine; and acrylonitrile. None of these nine substances were routinely monitored by any agencies contacted in any of the program areas, and no data was obtained.

TABLE 11

PCB's MONITORING SUMMARY

REGION & STATE	MEDIA					
	AIR	WATER	SOLID WASTE	HUMAN HEALTH	FISH & GAME	AGRICULTURE
I CONN.						•
I MASS.		•			•	
II N.J.		•				
II N.Y.					•	•
III DEL.		•				
III PA.		•		•		•
IV FLA.		•				•
IV GA.		•			•	•
IV N.C.		•				•
IV TENN.		•				•
V MICH.		•		•		•
VI TEX.		•		•		
VII IOWA						•
VII MO.						
VIII COLO.						
VIII UTAH.				•		•
IX CAL.		•			•	•
X IDAHO				•		
X OREG.						•
X WASH.		•				

• = Fairly routine monitoring, more than one-time surveys.

However, the Connecticut Health Department Laboratory and the Iowa Hygienic Laboratory had recently performed limited testing for benzene and methyl chloroform in connection with occupational health programs; and the Florida Department of Pollution Control had recently been involved with limited testing for organics in water.

SECTION 2

DESCRIPTION OF STATE TOXIC SUBSTANCES MONITORING CAPABILITIES

INTRODUCTION

One of the main objectives of this project is to report on the capabilities of the various state agencies in the area of toxic substances monitoring. The discussion of agency capabilities should include items such as size of monitoring network, analysis equipment available, quality control procedures, amount and type of toxic substances data generated, and anticipated future capabilities, for each agency and each toxic substance of interest. In order to obtain the information to describe agencies adequately MITRE defined a set of 25 key program descriptors and each monitoring agency and/or laboratory was asked in the course of the project to provide information on each descriptor. Responses from the agencies were recorded on capabilities descriptor forms such as the one shown as Figure 3 in the preceeding overview section. Table 12 lists the 25 descriptors used on the form.

Once a capability descriptor form had been completed for agencies in each of 20 states and for each of eight toxic substances they monitor, a complete set of 160 forms was available. These forms provide a description of the toxic substances monitoring capabilities of every agency contacted in 20 states which has monitored at least one of the toxic substances of interest. Rather than include all 160 basic forms in the body of this final report, the forms have been published separately as Volume V of the complete report.

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TABLE 12

CAPABILITY DESCRIPTORS FOR STATE AGENCIES

1. MEDIA SAMPLED
2. NO. OF SITES
3. SAMPLING FREQUENCY
4. EST. OBSERVATIONS PER YR.
5. INCLUSIVE DATES OF DATA
6. AMBIENT LEVELS
7. MONITORING OBJECTIVE
8. DATA STORAGE FORM
9. DATA RECORDING LAG
10. ANALYSIS PERFORMED
11. DATA RETENTION PERIOD
12. SAMPLE RETENTION PERIOD
13. DATA IN FED. SYSTEM
14. AVAILABILITY OF UPDATES
15. LAB USED
16. NO. OF LAB PERSONNEL
17. NO. OF DEGREED CHEMISTS
18. FORMAL LAB TRAINING PROGRAM
19. MAJOR EQUIPMENT
20. METHOD OF ANALYSIS
21. QUALITY CONTROL PROCEDURES
22. OTHER T.S. MON. CAPABILITY
23. FUTURE FOCUS OF MONITORING
24. ASSISTANCE DESIRED FROM EPA
25. OTHER COMMENTS

In addition to providing detailed information on the toxic substances monitoring capabilities and the availability and nature of the toxic substances data for each individual agency contacted, the descriptor forms contained in Volume V serve as a basic data base for any number of cross-summaries and analyses that OTS may find useful to make. For the overview section of this final report, MITRE aggregated all states and all toxic substances monitored for an analysis of overall monitoring capability in each program area (i.e., air, water supply, water quality, solid waste, human health, fish and wildlife, and agriculture). Obviously, analysis is possible on many other bases, such as geographically, for specific combinations of substances, for specific types of programs, for agencies with specific types of equipment, etc. The ordering scheme MITRE used in constructing the descriptor tables was the following:

State

Substance

Media/Program Area

Specific Agencies.

After the primary ordering were the 25 capabilities descriptors, describing the monitoring capabilities of the agencies.
With the tables available in Volume V, it is possible to order the data by any of 24 possible combinations, and then to summarize and analyze the data according to any combination of the 25 capability descriptors desired. For example, if it were necessary to know the

amount of monitoring done for cadmium in surface water by fish and wildlife agencies on the west coast whose data is not reported to STORET, this could be found by checking the appropriate descriptor tables in Volume V.

In this section of the final report, agency capabilities have been aggregated for all 20 states and the analysis is by each toxic substance monitored in each program area. A detailed summary table has been constructed for each substance, and the accompanying discussion is keyed to the capability descriptors shown on the tables. A far more detailed discussion of each specific agency contacted in each state and the arrangements made for data acquisition may be found in the four quarterly reports submitted to OTS during the course of the project and referenced in the introduction to this volume. The discussion by substance follows.

Arsenic (See Table 13)

1. Arsenic is monitored at a total of 25,005 sites in the 20 states in all media, which means that the substance is monitored at virtually all the sites where toxic substances are monitored. Most of the sites are in water, with 243 in air and only 30 in solid waste (only two solid waste agencies monitored toxic substances).

2. There are nearly 83,000 analyses done for arsenic per year by agencies in every program area. The majority of analyses are done by the water supply and water quality agencies.

TABLE 13
SUMMARY OF MONITORING CAPABILITY FOR ARSENIC IN 20 STATES

PROGRAM AREA							
PROGRAM DESCRIPTOR	AIR	WATER SUPPLY	WATER QUALITY	SOLID WASTE	HUMAN HEALTH	FISH & WILDLIFE	AGRI-CULTURE
1. TOTAL SITES	143	15,823	9,119	30	N.A.	N.A.	N.A.
2. TOTAL OBSERVATIONS PER YEAR	9,855	17,762	19,654	120	1,200	9,000	11,871
3. PERCENT DATA RECEIVED	93	91	94	100	75	- 0 -	60
4. MONITORING OBJECTIVE	BACKGROUND	POPULATION	COMPLIANCE	BACKGROUND	POPULATION	BACKGROUND	POPULATION
5. STORAGE FORM	LAB.	DATA SHEETS	COMPUTER	DATA SHEETS	DATA SHEETS	DATA SHEETS	DATA SHEETS
6. USE OF DATA	STATISTICS	STATISTICS	STATISTICS	STATISTICS	STUDIES CHECKED	STUDIES CHECKED	CHECKED
7. DATA RETENTION TIME	10+yrs.	10+yrs.	10+yrs.	5 yrs.	10+yrs.	10+yrs.	10+yrs.
8. SAMPLE REJ. TIME	10+yrs.	- 0 -	- 0 -	- 0 -	- 0 -	- 0 -	- 0 -
9. TICKET/SAMPLE	- 0 -	6 of 16	14 of 19	N.A.	N.A.	N.A.	N.A.
10. LAB TYPE	GOV LAB	GOV LAB	GOV LAB	CONTRACTS	GOV LAB	GOV LAB	GOV LAB
11. AVG. NO. LAB PERSONNEL (MONTHS)	24/0	17/10	17/11	170/23	12/5	3/1	16/18
12. TYPE TRAINING	OJT	OJT	OJT	OJT +	OJT	OJT +	OJT
13. LABS WITH QC & AS	1 of 9	14 of 15	16 of 17	1 of 1	1 of 4	1 of 1	8 of 9
14. CAN DO ADDITIONAL TOXIC SUBSTANCES	1 of 9	11 of 14	16 of 17	1 of 1	1 of 4	1 of 1	5 of 9
15. ANALYSIS METHOD	EPA	EPA/APHA	EPA	EPA	EPA	EPA	ASTM
16. QUALITY CONTROL	INT./EXT.	INT./EXT.	INT./EXT.	EPA/CO.	INT./EXT.	INT./EXT.	INT./EXT.
17. FUTURE MONITORING NEEDS	INCR. REQ.	MORE I.S.	MORE I.S.	MORE I.S.	INCR. REQ.	MORE I.S.	REMAIN SAME
18. HELP DESIRED	CON., TRA.	I. TRA.	I	I	CON., I	I	CON.

3. For all the agencies contacted which had data on arsenic, data has been received from 84 percent. This included agencies which submitted their data directly to SAROAD, STORET, or another Federal program. All agencies state that their data could be made available to EPA on request in the future, although the majority would require assistance for retrieval and copying. The specific reasons some data was not obtained are discussed in Volume III.

4. The prevalent reason for monitoring arsenic in the various program areas was basically the same as the other toxic substances: population-oriented for water supply, human health, and agriculture; background monitoring for air and fish and wildlife; and compliance for solid waste and water quality.

5. From the air programs monitoring arsenic, data was received in a variety of forms--data sheets, compiled reports, and computer printouts. Of the other program areas except for water quality, where the majority of agencies had computerized data storage, the prevalent storage form was on data sheets.

6. The predominant use made of arsenic data by air, water and solid waste agencies was basic statistical analysis for their own file information. Agricultural agencies would generally only check the data to see if levels were within tolerances. In fish and wildlife and human health areas, arsenic levels were checked for tolerances and the data was used in detailed studies.

7. The only solid waste agency monitoring arsenic retained data for the current five years. All other agencies intended to

maintain historical data files for at least ten years, although few had arsenic data going back that far.

8. Air agencies monitoring arsenic intended to retain portions of Hi-Vol filter samples at least ten years. Some specific human health samples might be kept for varying lengths of time, but most were discarded after analysis was completed or were consumed in the analysis, as was true of all the other program areas. The only exceptions were where high levels were detected and the sample was required for possible litigation. In these cases, samples would be retained until the cases were resolved.

9. None of the air agencies monitoring arsenic have submitted the data to SAROAD except Texas, and since no code was available for Texas' X-ray fluorescence method, that data has not yet been entered into SAROAD. Three water supply agencies and 14 water quality agencies submit arsenic data to STORET.

10. All agencies except the one solid waste agency analyze for arsenic in the agencies' own laboratories. In the agency for solid waste, analysis was done under contract.

11. In all the laboratories which analyzed for arsenic, there were an average of 42 laboratory personnel, of whom an average of 11 were degreed chemists. The breakdown of average laboratory personnel and degreed chemists for each program area is shown in Table 13.

12. In laboratories where arsenic analysis is performed, the most common form of training is on-the-job-training, supplemented by outside training courses when schedules and resources allow. None of the laboratories reported having formal training programs.

13. In all program areas except air, 83 percent of agencies had use of atomic absorption and gas chromatograph equipment. Three of six air agencies had both units.

14. Eighty-five percent of air and water agencies, and all of the solid waste, human health, fish and wildlife, and agriculture agencies which monitored arsenic, felt they had the capability in terms of trained personnel and equipment to monitor almost any toxic substance that might be required from the OTS list. The only conditions were that a method of analysis be available and that the additional analysis could fit into their work load.

15. The prevalent analysis method for arsenic across the board except for agriculture was that recommended or endorsed by EPA. For agricultural agencies the most commonly referenced method was that recommended by the Association of Official Analytical Chemists.

16. Thirty-three of 52 agencies and laboratories reported that they employed both internal and external procedures for quality control. Specific procedures varied from laboratory to laboratory, but generally they included standards and duplicate samples in the laboratory and occasional check samples with outside laboratories.

17. The expected future focus of toxic substances monitoring varied from program to program. Air programs monitoring arsenic expected for the most part to increase network size and number of samples. In water 17 of 38 agencies felt that new regulations would require monitoring more substances than arsenic and the others they are currently doing. More metals and organics on the OTS list were also expected to be monitored in the areas of solid waste and fish and wildlife. Human health agencies expected less widespread analysis or random analysis for arsenic and more detailed study in specific areas of concern. One-half of the agricultural agencies expected the sample work load to remain about the same for the near future.

18. Responses to the question of what assistance from EPA would be most desirable varied within and among program areas. The most common assistance desired was research and development of standards for substances, development of methods of analysis for new toxic substances, and funds for additional personnel and equipment.

Beryllium (See Table 14)

1. Beryllium was monitored at a total of 7,039 sites in the 20 states--the least number of sites of any of the substances for which data was available. All but 235 of these sites were water quality and water supply sites in two states.

2. The total of all analyses for beryllium per year was 16,526, also the lowest number for all substances.

TABLE 14
SUMMARY OF MONITORING CAPABILITY FOR BERYLLIUM IN 20 STATES

PROGRAM AREA							
PROGRAM DESCRIPTION	AIR	WATER SUPPLY	WATER QUALITY	SOLID WASTE	HUMAN HEALTH	FISH & WILDLIFE	OCCU-PATIONAL
1. TOTAL SITES	145	1,021	5,791				5-8
2. TOTAL OBSERVATIONS PER YEAR	7,536	1,500	5,30	-	-		4,000
3. PERCENT DATA RECEIVED	100	100	100	-	-	-	7 -
4. MONITORING OBJECTIVE	BACKGROUND	POPULATION	VARI.	-	-		COMPLIANCE
5. DATA FLOW	COMPUTER	COMPUTER	COMPUTER	-	-		DATA SHEETS
6. USE OF DATA	STATISTICS	STATISTICS	STATISTICS	-	-	-	STATISTICS
7. DATA RETENTION TIME	10+yrs	10+yrs	10+yrs	-	-	-	10+yrs
8. SAMPLE RETENTION TIME	10+yrs	- 0 -	- 0 -	-	-	-	- 0 -
9. CHAIN-OF-CUSTODY	1 of 8	2 of 3	2 of 2	-	-	-	-
10. LAB TYPE	NON LAB	NON LAB	NON LAB	-	-	-	NON LAB
11. NUMBER AND TYPE PERSONNEL EMPLOYED	32/11	20/11	12/10	-	-	-	18/9
12. TYPE TRAINING	OJT	OJT	OJT	-	-	-	OJT
13. LABS WITH QC & AA	5 of 8	2 of 2	1 of 1	-	-	-	1 of 1
14. CAN DO ADDITIONAL TOXIC SUBSTANCES	6 of 8	1 of 2	1 of 1	-	-	-	1 of 1
15. ANALYSIS METHOD	EPA	EPA	EPA	-	-	-	USDA
16. QUALITY CONTROL	INT./EXT.	INT./EXT.	INT./EXT.	-	-	-	INT./EXT.
17. FUTURE MONITORING EFFORTS	INCR. NET	MORE I.D.	REMAIN SAME	-	-	-	REMAIN SAME
18. HELP NEEDED	S, VAR.	S	STDS.	-	-	-	STDS.

3. Including data in STORET, data was counted as received from all agencies which monitored beryllium except for the Connecticut Agricultural Station. That agency randomly samples food but compiles no data.

4. Objectives of monitoring for beryllium varied. In air it was primarily to determine background levels, in water supply it was population oriented, and for the water quality and agricultural agencies it was population and compliance oriented.

5. The predominant data storage form for 54 percent of air and water agencies was a computer system, and for the agricultural agency data sheets were used.

6. In all areas the most common use of the data was to determine basic statistics for the agencies own information. Air agencies reported that routine checking was also done to see if levels were excessive.

7. In nearly all cases it was the intention of the agencies to maintain data records at least ten years.

8. Air sample filters for beryllium were kept for at least ten years. In water and agriculture, samples were generally not retained beyond analysis except where required for possible litigation. In these cases, samples were kept until enforcement litigation was resolved.

9. Of eight air agencies monitoring beryllium, only Utah submits the data to SAROAD. Both of the water supply and water quality agencies submit beryllium data to STORET.

10. All of the agencies monitoring beryllium have control of their own laboratory, or of their own section within a larger

laboratory system.

11. For all laboratories monitoring beryllium, the average personnel strength is 22, 10 of whom are degreed chemists. Table 14 shows the breakdown for each program area.

12. For all program areas, the prevailing form of training is on-the-job-training. Some agencies reported that this is occasionally supplemented by outside training courses when schedules and resources permit.

13. Except for air, all agencies had access to atomic absorption and gas chromatograph equipment. All air agencies had atomic absorption units, which are required for trace metal analysis, and five of the eight monitoring beryllium did have gas chromatographs as well.

14. The majority of agencies in the programs where beryllium was monitored felt they could monitor most additional toxic substances if required, and all agencies felt they could do at least some additional ones. The only conditions were that a method of analysis be available for the substance, and time and personnel be available to do the analysis along with all other requirements.

15. Except for the agricultural agency, which reported using a USDA analysis method, all the agencies monitoring beryllium use the analysis method endorsed or recommended by EPA.

16. The most common quality control procedures reported were

both internal (calibration, standards, duplicates) and external (check samples with outside laboratories). Two air agencies (Utah and Wayne County, Michigan) reported that no formal quality control programs were being practiced.

17. The agricultural and water quality agencies expected their toxic substances monitoring to remain at about the same level in the near future. About 44 percent of air and 67 percent of water supply agencies anticipated increased networks and sampling and an increase in the number of substances sampled.

18. The assistance most desired from EPA varied among the agencies monitoring beryllium, but two items were prevalent. One was standards, both of acceptable levels of substances in the environment, and standard methods of analysis for new substances. The other commonly mentioned item was funding for more personnel and equipment.

Cadmium (See Table 15)

1. For the 20 states contacted, cadmium is monitored at an overall total of 25,380 sites. It is monitored at all the solid waste, water supply, and water quality sites where any toxic substances are monitored, and it is monitored at the majority of the air and fish and wildlife sites where metals are analyzed.

2. For all media, there are about 93,000 analyses done for cadmium per year by all agencies reporting. The predominant media is water, with a significant amount of sampling and analysis also

TABLE 15
SUMMARY OF MONITORING CAPABILITY FOR CADMIUM IN 20 STATES

done in the air and fish and wildlife areas.

3. The overall percentage of data acquisition from all agencies with some cadmium data was 86 percent. This includes those agencies sending data directly to SAROAD, STORET, or another Federal program. All agencies contacted felt that they would be able to send future updates if required, although some assistance may be needed for retrieving and copying data.

4. The objective of monitoring for cadmium varied within and among program areas. Eleven of 22 air agencies monitored to determine what background levels were, and at other air agencies the objective was population and compliance oriented. Sixty-eight percent of water quality, solid waste, and agricultural monitoring was compliance oriented. The water supply, fish and wildlife, and human health monitoring was primarily population oriented.

5. The predominant form of data storage for water quality, solid waste, human health, and 50 percent of water supply agencies, was computerization. For the other agencies, data was maintained on some form of data sheets.

6. The cadmium data was used in some sort of statistical analysis by the majority of agencies in the air, water, and fish and wildlife areas. In solid waste, human health, and agriculture, individual levels were checked mainly to determine if they were excessive.

7. Most agencies intended to retain cadmium data a minimum of ten years. Solid waste agencies expected to retain data at least five years, and the retention period among agricultural agencies ranged from one year to more than ten years.

8. Nine of 16 air agencies retained portions of filter samples for at least ten years. In all other areas, samples were not retained beyond analysis unless levels were significantly high. In these cases, samples were usually retained until enforcement litigation was resolved.

9. One of the 16 agencies reporting cadmium data submits the data to SAROAD. Six of 17 water supply agencies and 16 of 25 water quality agencies submit their data to STORET.

10. Except in the areas of fish and wildlife and solid waste, the majority of agencies perform cadmium analysis in their own laboratory. The solid waste analysis is done by contract laboratories, and the six fish and wildlife agencies monitoring cadmium are split among contract laboratories, shared facilities, and their own laboratories.

11. Overall, for all laboratories performing analyses for cadmium, there are an average of 42 personnel in the laboratory, of whom 15 are degreed chemists. The average proportions for laboratories in the various program areas are shown in Table 15.

12. For most laboratories, the primary training of personnel

is on-the-job training, with occasional outside courses when schedules and resources allow. No laboratory reported having a formal training program.

13. Almost 80 percent of agencies contacted had access to both atomic absorption and gas chromatograph equipment. All air agencies had access to at least atomic absorption units, which are required in their trace metal analysis.

14. Based on the trained personnel and equipment available, 88 percent of the agencies monitoring cadmium felt they had the capability to monitor most other toxic substances on the OTS list if required. Every agency felt it could do at least some additional substances. The only conditions were that a method of analysis be available and that resources be provided for more personnel and equipment if new analytical burdens interfered with existing work loads.

15. In the air, water, and solid waste areas, the method of analysis for cadmium most frequently referenced was the atomic absorption method recommended or endorsed by EPA. In human health and agriculture, it was the FDA and Association of Official Analytical Chemists standard method, and for fish and wildlife agencies a variety of standard methods were reportedly used, the most common being that recommended by EPA.

16. Except for three air agencies which reported no programs and several water and agricultural agencies which had only internal

programs, 49 percent of the agencies in all areas have both internal and external quality control programs. Internal procedures included calibrations, standards, and duplicate samples; and external procedures usually included exchanging check samples with Federal or other laboratories.

17. Views of the future focus of monitoring varied considerably within and among program areas. Eighteen of 19 air agencies expected to see more substances monitored and an increase in network size and number of samples, as was also true of 33 of 44 water supply and water quality agencies. Solid waste anticipated that more toxic substances would be monitored, agriculture expected about the same level of effort, human health looked for a decrease in random sampling with a concentration on problem areas, and fish and wildlife was divided among agencies which expected to expand sampling, decrease sampling, and remain at about the same level.

18. As was the case for the aggregate of all agencies monitoring all substances, of all the areas of assistance from EPA which would be most useful to agencies monitoring cadmium, two were primary. These were standards for levels of toxic substances in the environment and standard methods for their measurement, and funds for additional equipment and personnel. There were also a variety of individual items mentioned by specific agencies. (See Volume V for other items mentioned).

Chromium (See Table 15)

1. Chromium is monitored at nearly 25,000 sites in the 20 states contacted. It is monitored at all solid waste sites where

TABLE N
SUMMARY OF MONITORING CAPABILITY FOR CHROMIUM IN 20 STATES

toxic substances are monitored, at nearly all the water supply and water quality sites, and the majority of fish and wildlife sites, and at about half of the air sites.

2. Over 81,000 analyses are made for chromium per year by agencies in all the program areas combined. Water sample analysis accounts for about 63,500 of this total.

3. For all agencies which conducted chromium analysis, data was considered received from 83 percent. This includes agencies which submitted their chromium data directly to SAROAD, STORET, or another Federal program. For specific reasons some data was not collected, see Volume III.

4. Similar to the situation for other toxic metals, the monitoring objectives varied within and among program areas. The primary objective for air and fish and wildlife programs was background level determination. In water supply, the objective was primarily population oriented, while for water quality, solid waste, and agriculture, it was compliance.

5. Computer systems were used for data storage for 53 percent of agencies in air, water quality, and solid waste which monitor chromium. For water supply, fish and wildlife, and agriculture, the data sheets were used for storage.

6. For 65 percent of agencies in all program areas monitoring chromium, the use made of the data was in basic statistical analyses for the agencies' own information files.

7. Except for two solid waste agencies, which reported at least a five-year data retention period, 39 of 47 agencies in the program areas where chromium is monitored retain (or intend to retain) their data for at least ten years.

8. Three of five air agencies retained portions of Hi-Vol filter samples at least ten years, and the minimum retention period for any of them was five years. In the other areas, agencies generally do not retain samples after initial analysis unless levels are significantly high and the samples may be required in litigation. In those cases, samples are retained until litigation is resolved.

9. None of the five air agencies which monitor chromium submit their data to SAROAD. Five of 16 water supply agencies and 15 of 21 water quality agencies submit chromium data to STORET.

10. Sixty percent of all agencies analyze chromium at their own laboratory. The solid waste analysis is done by contracted laboratories, and the fish and wildlife analysis is divided among contracted laboratories, shared facilities, and one agency's own laboratory.

11. For all laboratories which do analyses for chromium, the average number of laboratory personnel is 34, 17 of whom are degreed chemists. Breakdowns of average personnel strength and number of chemists for each program area are shown in Table 16.

12. As was the case for all laboratories generally, the most common form of training in laboratories which analyze for chromium is on-the-job-training. In some agencies this is supplemented with outside courses when resources and schedules allow. None of the agencies monitoring chromium had formal training programs.

13. In all program areas except air, the majority (81 percent) of agencies had access to both gas chromatograph and atomic absorption equipment for analysis. All the air agencies had access to atomic absorption equipment, which they used for analysis of chromium and other toxic metals.

14. Of all agencies contacted which did analyses for chromium, 85 percent felt they could also monitor most other toxic substances on the OTS list if a method of analysis were available and if the additional analytical burden did not interfere with their present work load.

15. For air, water, solid waste and fish and wildlife agencies, the primary methods of analyses employed were standard atomic absorption methods recommended or endorsed by EPA. Agricultural agencies used standard methods recommended by the USDA and Association of Official Analytical Chemists.

16. One air agency reported no quality control program, and three water supply and six water quality agencies reported using only internal quality control procedures. All other agencies monitoring chromium used a combination of internal and external quality control procedures in their laboratories.

17. There was considerable variety in what agencies viewed as the future focus of toxic substances monitoring. In general, most air, water, solid waste, and fish and wildlife agencies expected to increase network size, number of samples, and number of substances; although some agencies in each area expected the level of effort to remain about the same. Both agricultural agencies monitoring chromium expected the level of monitoring to remain the same in the near future.

18. Although there were a variety of responses from agencies in all areas as to what assistance from EPA would be most useful, two items continued to stand out. These were that EPA should develop standards for levels of substances in the environment and standard methods for measuring the substances; and that EPA should provide funds for additional manpower and equipment for toxic substances monitoring. After these two major items, there were a variety of specific items mentioned by various agencies. (See Volume V tables for other items mentioned).

Cyanide (See Table 17)

1. In the 20 states contacted cyanide is monitored at 19,647 sites. All these sites are either water supplied or water quality stations.

2. There are on the average about 44,000 analyses done for cyanide per year by water supply, water quality, fish and wildlife, and agricultural agencies. The bulk of these are in the water media.

TABLE 17
SUMMARY OF MONITORING CAPABILITY FOR CYANIDE IN 20 STATES

	PROGRAM AREA						
PROGRAM CHARACTER	AIR	WATER SUPPLY	WATER QUALITY	SOLID WASTE	HUMAN HEALTH	FISH & WILDLIFE	AGRI-CULTURE
1. TOTAL STATIONS	-	12,000	5,000	-	-	-	-
2. TOTAL OBSERVATIONS PER YEAR	-	7,320	24,880	-	-	8,000	6,000
3. PERCENT DATA RECEIVED	-	80	92	100	-	- 0 -	- 0 -
4. MONITORING OBJECTIVE	-	POPULATION	COMPLIANCE	COMPLIANCE	-	BACKGROUND	COMPLIANCE
5. STORAGE FORM	-	VAR.	COMPUTER	DATA SHEETS	-	DATA SHEETS	DATA SHEETS
6. USE OF DATA	-	STATISTICS	STATISTICS	STATISTICS	-	CHECKED	STATISTICS
7. DATA RETENTION TIME	-	10+yrs	10+yrs	5+yrs	-	10+yrs	10+yrs
8. SAMPLE RETENTION TIME	-	- 0 -	- 0 -	- 0 -	- 0 -	- 0 -	- 0 -
9. YES/NO/ABROAD	-	4 of 10	11 of 12	-	-	-	-
10. LAB TYPE	-	OWN LAB	OWN LAB	CONTRACTED	-	OWN LAB	OWN LAB
11. AVG. NO. LAB PERSONNEL/ CHEMISTS	-	17/9	20/11	40/35	-	5/3	41/27
12. TYPE TRAINING	-	OJT +	OJT	OJT +	-	OJT +	OJT
13. LABS WITH QC & QA	-	9 of 10	10 of 12	1 of 1	-	1 of 1	2 of 2
14. CAN DO ADDITIONAL TOXIC SUBSTANCES	-	5 of 10	9 of 12	1 of 1	-	1 of 1	2 of 2
15. ANALYSIS METHOD	-	APHA/EPA	APHA/EPA	EPA	-	EPA	USDA/AOAC
16. QUALITY CONTROL	-	INT./EXT.	INT./EXT.	INT./EXT.	-	INT./EXT.	INT./EXT.
17. FUTURE MONITORING FOCUS	-	VAR.	VAR.	INCR. SPL., MORE T.S.	-	MORE T.S.	REMAIN SAME
18. HELP DESIRED	-	VAR.	VAR.	S	-	S	STDS.

3. For all agencies monitoring cyanide in the 20 states, data was obtained from 77 percent. This percentage includes agencies submitting data to STORET or another Federal program directly. All agencies with cyanide data indicated their willingness to submit updates in the future if required.

4. The predominant monitoring objectives were population oriented for water supply agencies, (i.e., checking levels which may endanger human health), determination of background levels for fish and wildlife, and compliance oriented for water quality, solid waste, and agricultural programs.

5. The most commonly data storage form was the computer for water quality, divided between the computer and data sheets for water supply, and data sheets for fish and wildlife and agricultural agencies.

6. Fish and wildlife cyanide data is checked to see if levels are significantly high. For other program areas, the main use of the data is in some basic statistical analysis.

7. The solid waste agency monitoring cyanide retains that data at least five years. For all other areas the retention time is at least 10 years.

8. No agency contacted keeps samples after they have been analyzed for cyanide unless high levels are encountered and the samples may be needed in litigation. In these cases the samples are retained until the litigation is resolved.

9. Four of 10 water supply agencies submit cyanide data to STORET, as do 11 of 12 water quality agencies. No air agency

monitors cyanide.

10. Except for solid waste, where analysis is done by laboratories under contract, the majority of agencies performed the analyses in their own laboratory.

11. The average number of personnel in laboratories conducting cyanide analyses in the 20 states is 25, 16 of whom are degreed chemists. Table 17 shows the average breakdown of personnel and degreed chemists per laboratory in each program area.

12. The most common type of training is on-the-job-training, supplemented in some agencies by outside training courses. No laboratory reported a formal training program.

13. Of the agencies monitoring cyanide, 89 percent had both gas chromatograph and atomic absorption equipment.

14. Eighty-one percent of the agencies monitoring cyanide felt they had the capability for analyzing most additional toxic substances on the OTS list if analysis methods were available. All the agencies felt they could do at least some additional substances. Resources would be required in most cases for more people and equipment if analytical requirements were significantly expanded.

15. The primary method used for determining cyanide in water is the standard colorimetric method endorsed by the American Public Health Association and EPA. For solid waste and fish and wildlife, EPA's recommended standard method is reported to be used. In agriculture, the standard method recommended by the USDA and the

Association of Official Analytical Chemists is used.

16. Two water supply and two water quality agencies reported using only internal quality control procedures in the laboratory. All other agencies used procedures of quality control that included both internal checks and interlaboratory testing.

17. There were a variety of views as to the future focus of toxic substances monitoring among the various agencies. In water supply and water quality, there was a split among agencies which expected to increase sampling and network size, increase number of substances sampled, and maintain about the same level of effort. The one solid waste agency expected to increase both sampling and the number of substances monitored. The one fish and wildlife agency monitoring cyanide expected to monitor more toxic substances. Agricultural agencies expected to remain at about the same level of effort, with perhaps some increase in the number of substances monitored.

18. There were a variety of items that the agencies would like in the way of assistance from EPA, but again these were in two primary categories. The agencies would like EPA to develop standards for levels of toxic substances in the environment and standard methods for measuring new substances, and they would like additional funds for more people and equipment. There also was a large variety of specific items mentioned by the agencies.

Lead (See Table 18)

1. Lead is monitored at 25,058 sites in the 20 states, which is all but 461 of the total toxic substances monitoring sites reported. All water supply and solid waste sites are used to monitor lead, as are most of the sites for air, water quality, and fish and wildlife.

2. There are about 110,000 analyses done for lead per year by agencies in the 20 states. This is more analyses than for any other single toxic substance. About 80 percent of the observations are in the air and water media.

3. For all agencies contacted with lead data, about 90 percent of the data is counted as received. This includes agencies reporting data to the SAROAD and STORET systems and to other Federal programs directly. The reasons that some lead data was not received are discussed in Volume III by agency.

4. For 54 percent of agencies in air, solid waste, fish and wildlife, and agriculture, the main reason given for monitoring lead was to determine background levels. In both air and agriculture there were also a number of agencies who reported the objective as population oriented and compliance. In the areas of water supply and human health, 20 of 34 agencies considered lead monitoring to be populatation oriented. For the 14 of 30 water quality agencies, monitoring was done to ensure compliance with regulations.

TABLE 18
SUMMARY OF MONITORING CAPABILITY FOR LEAD IN 20 STATES

	PROGRAM AREA						
PROGRAM DESCRIPTOR	AIR	WATER SUPPLY	WATER QUALITY	SOLID WASTE	HUMAN HEALTH	FISH & WILDLIFE	AGRI-CULTURE
1. TOTAL SITES	565	15,612	8,812	30	-	99	-
2. TOTAL OBSERVATIONS PER YEAR	16,522	24,262	43,846	120	4,230	9,130	11,748
3. PERCENT DATA RECEIVED	95	88	92	100	78	80	90
4. MONITORING OBJECTIVE	BACKGROUND	POPULATION	COMPLIANCE	BACKGROUND	POPULATION	BACKGROUND	COMPLIANCE, BACKGROUND
5. STORAGE FORM	DATA SHEETS	DATA SHEETS	COMPUTER	COMPUTER	DATA SHEETS	DATA SHEETS	DATA SHEETS
6. USE OF DATA	STATISTICS	STATISTICS	STATISTICS	STATISTICS	VAR.	STATISTICS	COMPLIANCE
7. DATA RETENTION TIME	10+yrs	10+yrs	10+yrs	5+yrs	10+yrs	10+yrs	10+yrs
8. SAMPLE RETENTION TIME	10+yrs	- 0 -	- 0 -	- 0 -	VAR.	- 0 -	- 0 -
9. STORET/SAROAD	3 of 21	6 of 17	15 of 24	N.A.	N.A.	N.A.	N.A.
10. LAB TYPE	OWN LAB	OWN LAB	OWN LAB	CONTRACTED	OWN LAB	VAR.	OWN LAB
11. AVG. NO. LAB PERSONNEL/ CHEMISTS	31/13	18/10	18/11	170/25	77/29	30/24	31/16
12. TYPE TRAINING	OJT +	OJT	OJT +	OJT +	OJT	OJT +	OJT
13. LABS WITH GC & AA	12 of 21	14 of 17	20 of 24	1 of 1	7 of 9	5 of 5	9 of 10
14. CAN DO ADDITIONAL TOXIC SUBSTANCES	16 of 21	12 of 17	22 of 24	1 of 1	8 of 9	4 of 5	9 of 10
15. ANALYSIS METHOD	EPA	APHA/EPA	EPA/APHA	EPA	EPA/FDA	VAR.	AOAC
16. QUALITY CONTROL	INT./EXT.	INT./EXT.	INT./EXT.	INT./EXT.	INT./EXT.	INT./EXT.	INT./EXT.
17. FUTURE MONITORING FOCUS	INCR. NET MORE T.S.	VAR.	MORE T.S. VAR.	MORE T.S.	VAR.	VAR.	REMAIN SAME
18. HELP DESIRED	VAR.	$, VAR.	$, VAR.	$, VAR.	$, VAR.	STDS., $	STDS., $

5. For water quality and solid waste agencies monitoring lead, the most common data storage from is by computer. For all other agencies, the most common form is data sheets.

6. For most agencies in most program areas, the predominant use made of the data after it is generated is basic statistical analysis for the agencies' information files.

7. Solid waste agencies report that they maintain data files for at least five years. Eighty-one percent of all other agencies keep data records for at least 10 years.

8. The most common air sample retention time for agencies monitoring lead is at least 10 years. Some human health and agricultural samples are retained for shorter periods of time, but for the most part, with the exception of air filters, samples are not retained after analyses are completed. In some agencies, samples showing high lead levels will be retained for possible use in litigation. These samples would be kept until the cases were resolved.

9. Three of 20 air agencies which monitor lead submit their data to SAROAD. Six of 17 water supply agencies and 15 of 24 water quality agencies submit data to STORET.

10. Sixty-seven percent of the agencies in all program areas except solid waste and fish and wildlife analyze for lead in their own laboratories. In solid waste the analysis is done by a laboratory under contract, and in fish and wildlife, agencies use their own laboratories, contracted laboratories, and laboratories shared with

other agencies.

11. For all laboratories where lead is analyzed in the 20 states, the average number of personnel per laboratory is 54 and an average of 18 of those are degreed chemists. The breakdown of average proportions by program area is shown in Table 18.

12. Training in 81 of 84 laboratories where lead is monitored is on-the-job-training, supplemented by some outside courses when possible. None of the laboratories reported having a formal training program.

13. For all program areas, 78 percent of the agencies had access to both gas chromatograph and atomic absorption equipment. Fewer air agencies had gas chromatograph equipment than was the case in other program areas, but lead and all the other toxic substances presently monitored in air can be analyzed by atomic absorption methods, and all air agencies had atomic absorption units.

14. Of the agencies monitoring lead, 83 percent felt they were capable of monitoring most additional toxic substances on the OTS list if required and if a method of analysis existed. If the additional analysis burden interfered with their existing work load, however, many agencies felt they would need more manpower.

15. The prevailing standard methods for lead analysis for air and solid waste agencies are those recommended or endorsed by EPA. Water agencies had preference for the EPA and the American Public Health Association standard methods. Human health was divided

between FDA and EPA methods, agricultural agencies primarily used Association of Official Analytical Chemists recommendations, and fish and wildlife agencies were divided among methods recommended by EPA, the American Public Health Association, the Association of Official Analytical Chemists, and the instrument manufacturer.

16. Two air agencies reported no quality control programs in effect, and 20 agencies across all program areas had only internal quality control procedures. The majority of agencies (45 of 82) in all program areas, however, had programs which included both internal and external quality control procedures. Internal checks included calibration, standards and duplicate samples; and external procedures ranged from check samples exchanged with other laboratories to certification by the appropraite association or Federal agency.

17. Responses from agencies regarding how they saw the future focus of toxic substances monitoring varied considerably from agency to agency. Most of the air agencies foresaw increases, either in the amount of sampling or the number of substances sampled. In water the prevalent expectation was for more substances to be monitored, as was the case in solid waste. In human health, agencies were almost evenly split among the choices of increasing amount of sampling, decreasing amount of sampling, increasing number of substances sampled, and remaining about the same; and

a somewhat similar split was found in the fish and wildlife programs. The prevalent expectation among agricultural agencies was that the monitoring level-of-effort would remain about the same.

18. As was reported for other substances, agencies which monitor lead had a variety of responses when asked what assistance from EPA would be most helpful to them. Nevertheless two themes continued to predominate. These were a need for EPA to develop standards for levels of toxic substances in the environment and standards for measurement of new substances, and a need for EPA to provide funds for more personnel and equipment.

Mercury (See Table 19)

1. Mercury was monitored at 19,866 sites in the 20 states, all but 117 of which were water supply or water quality stations in the 20 states.

2. There are about 78,900 analyses done for mercury each year, and nearly 70 percent of these involved samples analyzed by water agencies.

3. For all agencies contacted in the 20 states which had mercury data, data was received from 75 percent. Data which was not received is discussed in Volume III.

4. Monitoring objectives varied by program area. The primary objective for air and fish and wildlife agencies monitoring mercury was to determine background levels. Compliance and population orientation (i.e., checking for levels hazardous to human health) were the main objectives of most agencies in the other program areas.

TABLE 19
SUMMARY OF MONITORING CAPABILITY FOR MERCURY IN 20 STATES

PROGRAM DESCRIPTION	PROGRAM AREA						
	AIR	WATER SUPPLY	WATER QUALITY	SOLID WASTE	HUMAN HEALTH	FISH & WILDLIFE	AGRI-CULTURE
1. TOTAL SITES	65	10,723	9,026	30	-	22	-
2. TOTAL OBSERVATIONS PER YEAR	2,158	11,000	43,204	120	3,530	7,167	11,723
3. PERCENT DATA RECEIVED	75	62	82	100	80	80	67
4. MONITORING OBJECTIVE	BACKGROUND	POPULATION	COMPLIANCE, VAR.	COMPLIANCE	POPULATION	BACKGROUND	POPULATION/ COMPLIANCE
5. STORAGE FORM	DATA SHEETS	DATA SHEETS	COMPUTER	COMPUTER	DATA SHEETS	DATA SHEETS	DATA SHEETS
6. USE OF DATA	VAR.	STATISTICS	STATISTICS	STATISTICS	STUDIES	STATISTICS	CHECKED
7. DATA RETENTION TIME	10+yrs	10+yrs	10+yrs	5+yrs	10+yrs	10+yrs	VAR.
8. SAMPLE RETENTION TIME	10+yrs	- 0 -	- 0 -	- 0 -	-0-, VAR.	- 0 -	- 0 -
9. STORET/SAROAD	1 of 4	5 of 13	14 of 21	-	-	-	-
10. LAB TYPE	OWN LAB	OWN LAB	OWN LAB	CONTRACTED	OWN LAB	VAR.	OWN LAB
11. AVG. NO. LAB PERSONNEL/ CHEMISTS	40/7	16/11	15/11	105/30	93/34	17/12	32/16
12. TYPE TRAINING	OJT +	OJT +	OJT +	OJT +	OJT	OJT +	OJT
13. LABS WITH GC & AA	3 of 4	10 of 13	17 of 22	2 of 2	5 of 5	7 of 10	7 of 9
14. CAN DO ADDITIONAL TOXIC SUBSTANCES	4 of 4	9 of 13	17 of 22	2 of 2	5 of 5	7 of 10	7 of 9
15. ANALYSIS METHOD	EPA	EPA/APHA	EPA/APHA	EPA	VAR.	EPA/APHA	VAR.
16. QUALITY CONTROL	INT./EXT.	INT./EXT.	INT./EXT.	INT./EXT.	INT./EXT.	INT./EXT.	INT./EXT.
17. FUTURE MONITORING FOCUS	INCR. NET MORE T.S.	VAR.	VAR.	INCR. NET MORE T.S.	VAR.	INCR. NET MORE T.S.	REMAIN SAME
18. HELP DESIRED	STDS., VAR.	$, VAR.	$, VAR.	$	VAR.	$	STDS., VAR.

5. Except for water quality and solid waste, where most of the agencies computerized their data, the most common form of data storage was data sheets.

6. Human health agencies usually used their mercury data in detailed studies of potential health effects, and agricultural agencies checked the data to be sure no significantly high levels were encountered. For 64 percent of the other agencies, the data was processed for basic statistics for their own information files.

7. In solid waste, data was expected to be kept for at least five years, and in agriculture the time period varied among agencies from one year to more than 10 years. For most of the remaining agencies, data records were expected to be kept at least 10 years.

8. Air agencies monitoring mercury generally keep portions of Hi-Vol air filters for 10 or more years, and human health agencies keep some samples for short periods of time. Most of the other agencies, however, do not retain samples after analysis unless high levels are determined and there may be a need for the sample in litigation. In such cases, samples are retained until the litigation is resolved.

9. One of four air agencies monitoring mercury submits the data to SAROAD. Five of 13 water supply agencies and 14 of 21 water quality agencies submit data to STORET.

10. Forty of 64 agencies have their own laboratories for mercury analyses. The solid waste agencies contract their analyses to other laboratories; and of the seven fish and wildlife agencies monitoring mercury, three have their own laboratories, three share facilities with other agencies, and one contracts for the analyses.

11. For all laboratories doing analyses for mercury in the 20 states, the average number of personnel per agency is 45, 17 of whom are degreed chemists. The average personnel breakdown by agency is shown in Table 19.

12. For all agencies contacted, except one in water supply and one in fish and wildlife which reported no program, the training carried on in the laboratories is primarily on-the-job type training. In several agencies this is supplemented by occasional outside training courses. No agency reported a formal training program.

13. As Table 19 shows, nearly all agencies in all program areas have access to both gas chromatograph and atomic absorption equipment.

14. Of all agencies monitoring mercury, 79 percent felt they were capable of monitoring most toxic substances on the OTS list if required. The conditions were that a method of analysis be available and that no undue additional analytical burden be placed on their staffs unless funds were provided for more people.

15. Except in the areas of human health and agriculture, the prevalent standard methods of analysis for mercury in the various media were those recommended or endorsed by EPA. In human health and agricultural agencies, the standard methods referenced were those of the FDA, USDA, EPA, Association of Official Analytical Chemists, and American Public Health Association.

16. One air agency reported no quality control program, and nine agencies in other program areas reported only internal quality control procedures. For 30 of a total of 54 agencies, quality control procedures included both internal checks and inter-laboratory testing.

17. Views of the anticipated future focus of toxic substances monitoring differed within and among program areas. For the most part, air, water, solid waste and fish and wildlife agencies expected increases in amount of sampling and in number of substances monitored. The prevalent expectation for human health and agricultural agencies was that the level of effort would remain about the same.

18. When agencies monitoring mercury were asked what assistance from EPA would be most helpful, there were a wide variety of responses. However, two themes predominated. The agencies wanted EPA to develop standards for levels of toxic substances in the environment and standard methods of measurement for new substances, and they wanted additional funds for personnel and

equipment. After those two principal items, there were a wide range of other specific items mentioned by individual agencies.

PCB's (See Table 19)

1. In the 20 states contacted, PCB's were monitored at a total of 3,246 sites. Most of these were water supply and water quality sites, and there was no reported monitoring of PCB's at air or solid waste sites.

2. The total number of analyses made for PCB's per year was 36,390. The largest number of analyses were performed by agricultural agencies, mainly as a sideline of chlorinated hydrocarbon pesticide residue analysis.

3. For all agencies contacted which had PCB data, data was counted as received from 87 percent. This includes agencies which submitted data to STORET or to another Federal program. Data which was not received is discussed in Volume III.

4. The main objective of monitoring PCB's in the fish and wildlife program area was to determine background levels. Water supply and human health agencies conducted monitoring for population-oriented objectives, and the primary objective of water quality and agricultural agencies was compliance.

5. For most water agencies, the computer was the data storage form. For most other agencies the data was stored on data sheets.

6. Once generated, the data was used in basic statistical analysis for their own information by most water agencies. Most health

TABLE 20
SUMMARY OF MONITORING CAPABILITY FOR PCB IN 20 STATES

PROGRAM DESCRIPTOR	PROGRAM AREA						
	AIR	WATER SUPPLY	WATER QUALITY	SOLID WASTE	HUMAN HEALTH	FISH & WILDLIFE	TISSUE CULTURE
1. TOTAL SITES	-	2,535	693	-	-	18	-
2. TOTAL OBSERVATIONS PER YEAR	-	1,024	10,270	-	3,100	7,012	14,984
3. PERCENT DATA RECEIVED	-	60	100	-	50	100	91
4. MONITORING OBJECTIVE	-	POPULATION	COMPLIANCE	-	POPULATION	BACKGROUND	POPULATION
5. STORAGE FORM	-	COMPUTER	COMPUTER	-	DATA SHEETS	DATA SHEETS	DATA SHEETS
6. USE OF DATA	-	STATISTICS	STATISTICS	-	STUDIES	STUDIES	CHECKED
7. DATA RETENTION TIME	-	10+yrs	10+yrs	-	10+yrs	10+yrs	10+yrs
8. SAMPLE RETENTION TIME	-	- 0 -	- 0 -	-	- 0 -	- 0 -	- 0 -
9. STORET/SAROAD	-	2 of 5	5 of 8	-	N.A.	N.A.	N.A.
10. LAB TYPE	-	OWN LAB	OWN LAB	-	OWN LAB	OWN LAB	OWN LAB
11. AVG. NO. LAB PERSONNEL/ CHEMISTS	-	10/8	16/12	-	206/80	13/7	31/16
12. TYPE TRAINING	-	OJT +	OJT	-	OJT	OJT +	OJT
13. LABS WITH GC & AA	-	3 of 5	8 of 8	-	2 of 2	3 of 4	11 of 11
14. CAN DO ADDITIONAL TOXIC SUBSTANCES	-	2 of 5	8 of 8	-	2 of 2	3 of 4	11 of 11
15. ANALYSIS METHOD	-	VAR.	EPA/APHA	-	FDA/EPA	EPA	FDA/AOAC
16. QUALITY CONTROL	-	INT./EXT.	INT./EXT.	-	INT./EXT.	INT./EXT.	INT./EXT.
17. FUTURE MONITORING FOCUS	-	MORE T.S.	VAR.	-	INCR. NET	MORE T.S.	REMAIN SAME
18. HELP DESIRED	-	$	VAR.	-	VAR.	$	STDS., $

and fish and wildlife agencies used the data in preparing detailed studies. In agriculture, the data was routinely checked for significantly high levels.

7. For 68 percent of agencies in all program areas, data on PCB's was expected to be retained at least 10 years.

8. Agencies analyzing for PCB's generally did not retain samples after analysis. The only exception was when high levels were determined and the sample might be needed in litigation. In these cases samples were usually retained until the litigation was resolved.

9. Two of five water supply agencies and five of eight water quality agencies report that they submit their PCB data to STORET.

10. All human health, fish and wildlife, and agricultural agencies monitoring PCB's perform the analysis in their own laboratories, as do nine of the 14 water agencies.

11. For all laboratories analyzing for PCB's, the average personnel strength is 55, 25 of whom are degreed chemists. Table 20 shows the breakdown of average personnel strength by program area.

12. One fish and wildlife agency reported no training program in the laboratory. Otherwise, nearly all agencies conducted on-the-job-training with occasional outside courses.

13. Ninety percent of agencies monitoring PCB's have access to both atomic absorption and gas chromatograph equipment. The latter is used in PCB analysis.

14. Nearly 87 percent of all agencies monitoring PCB's felt they had the capability to monitor most additional toxic substances on the OTS list if they were required to do so. The only conditions were that a method of analysis would be available for any new toxic substance, and that manpower assistance would be provided if the additional analytical burden were significant.

15. The most common among a variety of analysis methods referenced by the agencies were those recommended by the American Public Health Association and EPA for water analysis; and the recommendations of the Association of Official Analytical Chemists, EPA, and FDA for agencies in human health, fish and wildlife, and agriculture.

16. One agricultural agency reported no quality control program, and two water and two agricultural agencies reported having only internal quality control procedures. The remainder of the 30 agencies monitoring PCB's had both internal and external quality control procedures. Internal procedures generally included calibrations, standards, and duplicate samples. External procedures involved exchanging check samples with appropriate Federal and other laboratories.

17. The opinions of the agencies with regard to expected future focus of monitoring varied from agency to agency. However, the prevailing view in the water and fish and wildlife agencies was that the number of samples and number of toxic substances monitored

would increase in the near future. The two human health agencies were divided between increased sampling and remaining at the same level. Seven of 13 agricultural agencies felt monitoring of toxic substances would remain at about the same level as in recent years.

18. On the question of what assistance from EPA would be most helpful, 52 percent of the agencies stated that they could most use funds for personnel and equipment. The second most common response among these agencies was that EPA should develop standards for levels of toxic substances in the environment and standard methods of analysis for new toxic substances. After those two common responses, there were a variety of specific items mentioned by the agencies.

Other Toxic Substances

No agency in the 20 states contacted monitored any of the other toxic substances of interest, although in Connecticut, Florida, and Iowa there has been some limited specific testing for several of the substances in recent months.

SECTION 3

TOXIC SUBSTANCES PROBLEMS

AS PERCEIVED BY STATE AGENCIES

INTRODUCTION

A detailed discussion and presentation of summaries and analyses of the state agencies' toxic substances data has been included under separate cover as Volume IV of this final report. The Volume IV presentation includes a review of all the data that was made available by environmental, health, and various other agencies in 20 states during the course of this project. Because of the large volume and very wide variety of data in many media acquired on a number of the toxic substances of interest, and lack of consistency in sites, sampling frequency, and type of samples, it has not been possible within the resources of this project to prepare a comprehensive interpretive analysis of the situation with regard to each substance in the United States today. Additionally, the problem of analysis of a large amount of different, discrete, ambient data on a nation-wide scale has been compounded by data and information gaps in the areas of source identification information, health effects data, and the non-inclusion of ambient data already submitted to Federal data systems. Nevertheless, within the constraints of using only data provided by the agencies in 20 states as a base, an overview analysis of each toxic substance can be provided in terms of: general background information on the substance; why and how the state agencies perceive the substance as an environmental problem; what they believe to be the main sources of the substance in the environment; what trends their monitoring data show; and how they deal with any environmental threats posed by the substance.

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The remainder of this section consists of narrative overall analysis for each toxic substance based on the state data summaries and analyses contained in Volume IV. At the outset of each discussion, there is a brief background summary describing the substance and its known and suspected impacts, based on the existing literature familiar to nearly all the state agency officials contacted. From that point on, the discussion for each toxic substance is based on the data and information which was provided by the state agency officials themselves and summarized and analyzed by MITRE.

Arsenic

Arsenic compounds have long been known to be highly toxic and to accumulate readily in the human body. In addition to acute cases of ingestion and resulting poisoning, arsenic from the environment may enter the human body through inhalation, ingestion of food, water, and dust, and absorption through the skin. The principal means of excreting arsenic is through urine, and the body burden is also lowered through feces, skin, nails and hair. Ingestion of arsenic has been shown to cause dermatitis, heratosis, nausea, stomach pain, diarrhea or constipation, and edema, with the fatal dosage in the range of 70-180 mg. Inhalation causes bronchitis, nasal irritation, and in concentrated exposures, perforation of the nasal septum. From long term exposure, arsenic is believed to be carcinogenic, affecting the skin, lungs, and liver; and there is some evidence that it may be teratogenic as well. The potential carcinogenic effect of arsenic

is probably the most serious from an environmental point of view, since the arsenic can accumulate in the body over long periods of low-level exposure in the environment.

Officials of state agencies, because of familiarity with the existing literature as well as from their own experiences, were aware of the principal environmental sources of arsenic. Besides trace amounts which are believed to be naturally occurring and which occasionally are detected in drinking water supplies and surface and groundwater, there are several widely recognized areas of man-made arsenic contamination. Two of these are the processing of gold, copper, and other ores, including extraction and smelting; and residues resulting from pesticides used in the past which contained arsenic compounds such as lead arsenate. Besides these main sources, coal combustion is also believed to release small amounts of arsenic, as are some other specific industrial processes, and some phosphate detergents contain arsenic concentrations which are drained into waterways.

Because of the types of sources of arsenic, every type of monitoring agency has been involved in testing for arsenic in the 20 states contacted. Public drinking water supply agencies have monitored arsenic in all of the 20 states contacted. However, except for one or two localized, temporary problems in a few states, all water supplies have consistently been determined to be well within the Public Health Service standard of 0.05 mg/l for arsenic. The vast majority of drinking water supplies sampled have, in fact, been

reported as below the detectable limits of the method of analysis employed. Iowa has noted that arsenic levels in raw water supplies sometimes exceed the standards, but the levels drop after treatment for iron removal. Several states monitor agricultural foods routinely for arsenic because of its use in the organic form as a growth stimulant in feeds and also because of its use in pesticides.

The most outstanding environmental problems of arsenic pollution were reported from Tacoma, Washington and from El Paso, Texas. The Tacoma problem, according to state officials, arises from a copper smelter which is the largest source of arsenic in the western hemisphere. An extensive program of environmental monitoring is being pursued and a report sould be available soon through EPA Region X. Preliminary findings indicate a major output of arsenic into the atmosphere. Samples have been taken from humans, soil, water and air in the vicinity of the smelter. The early results showed that household dust had up to 427 ppm, hair up to 104 ppm and soil up to 797 ppm arsenic. The results have shown a correlation between the distance from the smelter and the concentration of arsenic in samples. In general, samples from sites and residents nearest to the smelter showed larger levels of the metal and these levels diminish with increasing distance from it. Arsenic levels in workers in the smelter were similar to levels in residents of the immediate area of the smelter. An examination of death records also revealed an increasing incidence of respiratory cancer among men who worked in the smelter. Arsenic was also a major pollutant in the emissions from

smelters in El Paso, Texas. The epidemological studies carried out in El Paso have not attributed specific cases of illnesses to arsenic. The emphasis in the El Paso study was on monitoring lead to substantiate its role in health effects which were demonstrated in residents of the immediate area.

Other states monitoring arsenic in air as a part of their heavy-metal program are New York, Pennsylvania, Tennessee, and Michigan. None of these states has reported any unusually high levels in ambient air and therefore no problems of arsenic air pollution are thought to exist. All the states contacted have monitored their water supplies for arsenic. It is usually done on the same frequency as the other metals: annually, biennially or triennially. Iowa is the only state contacted that has reported a localized problem of contamination, in surface water in Charles City, which has been traced by state officials to a pharmaceutical laboratory. New York has monitored solid waste leachate for arsenic from about 30 sites on a quarterly basis since 1973. From 22 samples done over that period from some of the sites, the average values were relatively low, ranging between 0.0 and 0.19 mg/1.

To summarize the activities of the states with respect to arsenic the following were the highlights:

- Arsenic is monitored in water by all 20 states. Iowa was the only state that report a localized case of arsenic pollution

in water.

- Six states monitored for arsenic in air: New York, Pennsylvania, Tennessee, Michigan, Texas and Washington. In Texas (El Paso) and Washington (Tacoma), arsenic from smelters is a probable health hazard.
- Human and household samples have been analyzed in Texas, Colorado, California and Washington. Vacuum dust from houses in El Paso and Tacoma showed very concentrated levels of arsenic.
- Arsenic is monitored routinely in agricultural products in about 10 states: Connecticut, New York, Pennsylvania, Georgia, North Carolina, Tennessee, Michigan, Utah, California and Oregon.
- Arsenic was not viewed by state agencies as a widespread environmental problem outside of El Paso, Texas, and Tacoma, Washington.

Beryllium

Over the past 30 years, the toxicity of beryllium has been established with regard to industrial exposure. The most common route of intoxication is through inhalation of dust or fumes containing beryllium and its compounds. Some uncertainty remains as to the pathogenesis of beryllium disease, but the principal effect is felt in the lungs and respiratory tract. Acute poisoning causes inflammation of the upper air passages leading to a pneumonia-like condition with fever, cough, and shortness of breath. The disease may last up to three months if it is not fatal, and in some cases chronic effects follow the acute form of the disease. Additional acute effects may include contact dermatitis, conjunctivitis, and

corneal burns. The main chronic effects of long term exposure to beryllium are granulomatous changes in the lungs. Granulated lesions are distributed throughout the lungs, which lead to coughing, progressive shortness of breath, weight loss, and sometimes fever and nausea. In some cases, weight loss is so severe that it may cause death in a matter of months. As beryllium disease progresses, granulomatous inflammation is frequently followed by scarring of lung tissue and damage to the heart. Beryllium compounds have caused carcinoma of the lungs in laboratory rats and monkeys, but the evidence that beryllium is carcinogenic to humans is not yet conclusive.

State agency officials contacted were generally aware of the toxicity of beryllium and of the principal sources of the metal and its compounds in the environment. Extraction of beryl ore in Utah is one potential source. The bulk of beryllium ore, however, is imported; and processing of the ore is concentrated in Pennsylvania and Ohio. While the chief hazard of exposure in processing plants has involved the workers, cases of neighborhood contamination have been reported in the literature. In these cases it was generally concluded that exposure resulted not so much from breathing contaminated air near processing plants, but rather from contact with beryllium dust from such sources as workman's clothing and shoes.

Beryllium has a number of very beneficial properties that make it useful in a variety of industries. These properties include stability,

high melting point, high strength-to-weight ratio, extreme hardness, and excellent ductility. When used as an alloy, it imparts increased resistance to shock, vibration, and corrosion to other metals. Because of these and other properties, beryllium and beryllium compounds have a wide variety of useful applications, ranging from the aerospace and nuclear industries to the manufacture of bicycle spokes, jewelry, and spark plugs. Consequently, there is a wide dispersion of the potential sources of beryllium contamination. According to the state agency officials contacted, however, there have not been reported cases of environmental contamination from these potential sources and the known cases involving beryllium disease resulted from occupational exposure. This was confirmed in discussions with staff members at the national Berylium Case Registry at Massachusetts General Hospital. Of more than 800 cases reported to the Registry, nearly all were the result of occupational exposure.

Despite its known toxicity, and its known occupational hazards, beryllium was not generally considered an environmental threat by state agency officials. This is reflected in the fact that it is the least monitored of all eight toxic substances on which states had some data. Because the main threat to human health is through inhalation, most of the monitoring that was done was carried on by air agencies. These were the agencies for the states of Connecticut, New York, Pennsylvania, Tennessee, Utah, and Michigan; and Wayne

County (Detroit), Michigan. In Utah, the monitoring was source-oriented. Three Hi-Vol samplers were operated near the only known beryllium mining operation in the United States. Data from Utah was in the process of being validated and compiled, and was not available when this report was prepared. The agency director stated that beryllium levels were usually very low, and that monitoring was done to see that they remained that way. For the other states beryllium was one of a number of metals analyzed to determine ambient background levels in the air throughout the state. In virtually all of this data, levels of beryllium were at or near the minimum detectable level.

Other than air, the only agencies with data on beryllium were the water quality agencies in Pennsylvania and New York. In New York, one of the primary reasons for monitoring beryllium was that the monitoring program is operated in cooperation with USGS, and beryllium is one of the metals which USGS regularly monitored in an extensive five year period. One of the reasons for monitoring beryllium in Pennsylvania water is that that state is a major processor of beryl ore. Since both of these states include their data in the STORET system, the data was not acquired at MITRE for summary and analysis.

Cadmium

Cadmium is one of the heavy metals which is widely used in industry for electro-plating and alloying in conjunction with lead, zinc or nickel. These uses expose workers to fumes, and the products

of plating and alloying are often used in food utensils which can contaminate food. The metal is usually manufactured as a by-product of lead, arsenic and zinc. Such mining operations release vast quantities of fumes and particulates which can further be transported by water and air to other areas of the environment. Cadmium is also released in the environment by crops which feed on phosphatic fertilizers which are obtained from naturally occurring rocks. All 20 states have shown a concern for the metal and therefore have monitored it in at least one media. The concern over it stems from its well established severe toxicity and suspected carcinogenic property. Much research has been done on its toxicity and the literature has many references of studies and cases indicating the toxic characteristics and the concomitant disease from high levels in animals and humans. Disease from cadmium poisoning reveals damage to the kidney, bone and lungs.

While none of the states which were visited reported any poisoning or disease outbreak as a result of cadmium ingestion, four have reported its presence in the environment, and surveys were initiated from the early 1970's to determine its concentration in different media. One of the most significant reports was from California where high levels of cadmium were found by the State Department of Agriculture in lettuce and other leafy vegetables grown in the Salinas Valley of the Monterrey Basin. A team of scientists and officials from the state resource and environmental

agencies and the Department of Toxicology at the University of California at Davis was formed to investigate the extent of cadmium pollution among other objectives. A monitoring program was set up and conducted up to the beginning of this year, and the data is now being validated for inclusion in a forthcoming report by the project team. Samples were taken from water, plants, soil, indigenous fauna (mainly rodents and fish). The preliminary findings indicated large concentrations of cadmium in many of the samples. The results also showed that levels in lettuce and spinach were several orders of magnitude above the ambient soil concentration. This led to the tentative conclusion that such leafy crops had an affinity for the metal which was stored in the leaves and tended to be at higher levels in the older leaves of the same plant. Preliminary findings suggest that the source was naturally occurring deposits of cadmium from phosphatic rocks which had eroded into the valley in which the vegetables were grown. This discovery of high cadmium levels in the Salinas Valley caused the temporary discontinuation of spinach production from the area. Independent studies were conducted by the state's Division of Geology and Mines and these phosphatic rocks were found to contain levels of cadmium as high as 625 ppm, as determined from 350 samples taken from 4-6 foot cores. The details of results from both surveys were not yet available, although published reports are anticipated soon.

There was a major concern with source emission of cadmium in El Paso, Texas. This resulted from a smelting complex which

is a major source of lead, copper and zinc. The operators of the smelter were taken to court and charged with violating the city/county and state standards for particulates, and they were ordered to institute the necessary installations for reducing the volume of particulate emissions. Particulates were monitored in El Paso with Hi-Vol sampling apparatus, from which samples were composited and analyzed for cadmium and other trace metals (see the arsenic and lead discussions). High levels of cadmium were found at all the sites throughout the sampling area. In 1972, 132 samples were analyzed from 23 sites, and the average value varied between 0.006 and 1.3 $\mu g/m^3$ of cadmium. For 1973, 238 samples were analyzed from 20 sites and gave an average value varying between 0.01 and 0.45 $\mu g/m^3$. The 1974 average values varied between 0.01 and 0.5 $\mu g/m^3$, with the 1975 values between 0.03 and 0.32 $\mu g/m^3$ cadmium. The data generally showed a decline in levels of cadmium over the 4-year period and reflected the use of additional controls on the stacks of the smelters.

A wide range of dust and soil samples were also analyzed and cadmium levels were unusually high. Illnesses which developed among residents in the immediate smelter area were attributed to lead poisoning, which was the predominant pollutant in the particulate emissions. No casualties of cadmium toxification were specifically identified, nor was any synergistic correlation established with lead or the other toxic metals present.

In Washington and Idaho where copper and lead smelters are operated, cadmium was also monitored in the samples taken from humans, water, air, dust and soil in the affected areas. While the thrust of the effort in Washington concerned arsenic, cadmium was also determined. The available data obtained by MITRE includes only five soil samples which were tested for cadmium in 1972. A more comprehensive report is being prepared and will undoubtedly include a wider range of samples. The five samples showed a range of 4 to 16 ppm of the metal. A preliminary conclusion from the Washington study is that death records showed an increased incidence of respiratory cancer among men who worked in the smelter. The cause of this was mainly attributed by state investigators to arsenic, but since cadmium is also suspected to be carcinogenic its role cannot be ignored. The Washington environmental agencies involved anticipate a more extensive investigation of the heavy-metal problem during which the specific role of single metals might be more clearly defined. The monitoring program in Kellogg, Idaho, a joint venture involving the State, EPA and CDC, will be a comprehensive investigation in the mold of the El Paso study. Data has been made available to the EPA Regional Office, and a final report is in preparation.

Other states monitoring cadmium in air are Connecticut, Delaware, Pennsylvania, Tennessee, Michigan, Missouri, Colorado and California. The values reported of ambient concentration in areas outside of the smelter influence are very low and range from no

detection to hundredths of a microgram per cubic meter. All the states report that they monitor water supplies for cadmium. No drinking water supply has indicated any appreciable levels and most record levels below detection limit of the atomic absorption instrumentation.

Connecticut, Massachusetts, New Jersey, and California have monitored cadmium in sea foods. In Massachusetts, between 1971 and 1973, there were 141 determinations for cadmium in shellfish, and the average concentrations ranged from 0.14 to 0.78 ppm. During the same period 42 samples of finfish were tested and average values varied between 0.0 and 0.83 ppm. Six hundred and twenty two (622) sediment samples taken from the same waters over the same period revealed average values of 2.37 to 14.74 ppm. The results indicated that cadmium wastes were getting into the waterways, and were thought by the state agencies to be due primarily to plating industries. At the same time the water itself showed average levels of 0.003 to 0.02 ppm from the analyses of over 400 water samples. The heavy metal survey in Connecticut from 1970 to 1974 investigated shellfish contamination. Cadmium was determined in 78 samples from different water bodies and the average value varied between 0.5 and 8 ppm. Six states -- Connecticut, New York, Florida, North Carolina, Colorado and Idaho -- reportedly monitor agricultural products for cadmium. No state except California has found any excessive levels in any of the products tested. Connecticut has also been doing additional research on the uptake of

cadmium and other heavy metals from soil fertilized with sanitary sludge. Colorado has done bioassays with cadmium using fish and other aquatic insects to evaluate tolerance levels, as well as the resulting physiological and anatomical defects which might be induced by the metal.

With regard to analytical procedures employed in the states, the initial efforts to analyze samples for cadmium were set back by difficulties in developing reproducible analytical procedures among the participants from the different agency laboratories. This was of specific relevance in California where the validity of high cadmium values concerned the researchers. Eventually, methods were satisfactorily worked out to effect adequate interlaboratory practices which gave confirmatory assurances to the results. All laboratories report that they use atomic absorption spectrophotometry except in California and Texas, where X-ray fluorescence (XRF) is used in air analyses.

All 20 states put cadmium high on their priority list in monitoring for trace metals. All have monitored it to some extent in water, and most indicate that a more frequent and comprehensive program will emerge with the implementation of the Safe Drinking Water Act. In the states where cadmium has been identified as a pollutant from stationary sources, the indication is that close monitoring will be continued, and the industries have cooperated in the monitoring and further control of emissions with additional

equipment. The data from sediment and biota indicate that cadmium wastes are getting into waterways, and the states have instituted additional discharge guidelines and closer surveillance of effluents. For example, Connecticut has specified that industrial wastes should contain no more than 0.5 ppm cadmium prior to discharge into the waterways. Although there is a US Public Health Service (US PHS) maximum limit of 0.01 ppm for drinking water, most states have not imposed local guidelines for water supplies; nor are there any for air emissions separate from particulate standards.

Chromium

Chromium was formerly regarded only as a toxic substance with no known beneficial value to human biologic activities. In 1974 the National Academy of Sciences noted, however, that it was indeed an essential element in minute concentration for plants, animals and man. A deficiency of chromium in the body has been known to cause impairment in glucose metabolism because of an apparent ineffectiveness of insulin. There is no known incidence of adverse effects from excessive ingestion or inhalation of chromium from the ambient environment. Injuries and illnesses resulting from the contact with or use of chromium compounds have occurred through accidents or with workers experiencing continuous exposure over a period of time. The respiratory tract and fat tissues have been found to accumulate it more than other tissues, but high levels have also been found in the skin, muscle, fat and the pancreas in reported cases.

Chromium is the fourth most abundant essential trace element and is found occurring in combination with other elements in ores and other deposits, and is widely used in industry for plating and alloying. It is found in soil, plants, air and water and can result from natural sources, industrial wastes or from the burning of wood and coal. The two most significant forms are the trivalent, stable and nontoxic form; and the water-soluble, corrosive, toxic, hexavalent form. Because of its suspected carcinogenic characteristic as well as the adverse health effects observed among industrial workers in chrome plating industries, most of the 20 states contacted have monitored for chromium in at least one media. Some states have been monitoring for hexavalent and total chromium, while the majority only monitor for total chromium. None of the states have reported any incidence of contamination in the water or food industries, but several have reported cases of chromium wastes getting in water systems mostly from plating industries. A summary of the salient findings from the states follows.

Connecticut, Tennessee, Texas and Missouri, were the only states in which chromium was monitored in the air. In 1973, 107 composite air samples were analyzed by St. Louis City for chromium. The average values for all eight sites varied between 0.001 and 0.016 $\mu g/m^3$. For the same year 199 quarterly composite air samples from about 55 sites in Connecticut were analyzed. These are low levels and would not seem to indicate any direct source of emission.

The average values per site varied between 0.0015 and 0.0120 $\mu g/m^3$. In Connecticut and New York, chromium has been monitored for the past two years in ground water from wells in the vicinity of solid waste disposal areas. No significant levels were reported in the results of chemical analyses. Food laboratories under the state departments of agriculture in Connecticut, New York and California check food products routinely and none has reported any appreciable levels of the metal. Fish surveys for heavy metals in California, Connecticut and Massachusetts have checked different varieties of shell and fin fish for chromium. The results from a shellfish survey in Connecticut show low levels of chromium. Eighty five samples were analyzed and gave average values of 0.60 to 1.60 ppm. The survey in Massachusetts included samples of fish, sludge, core and sediments. Between 1971 and 1974, 141 samples of shellfish were analyzed for chromium. The average values of chromium reported varied between 0.91 and 2.25 ppm for the four years. Finfish reported somewhat lower levels of between 0.3 and 0.96 ppm from 60 samples analyzed between 1971 and 1973. Sediment samples analyzed between 1971 and 1973 revealed average values of 12.2 to 175.4 ppm. The level of the metal detected in water was substantially lower and ranged between 0.12 and 0.0002 ppm according to results of 382 water samples analyzed between 1971 and 1972. The high levels of chromium noted in these Massachusetts samples were attributed by the state agency to industrial waste from plating industries. The high level in the sediment and biota with contrastingly

low levels in water further illustrate the build-up of trace contaminants in the food chain even though levels in the ambient water are low.

All 20 states monitor water systems for chromium. The systems chosen are either ones involved in a public water supply or rivers and streams known or suspected to be receiving industrial wastes, which are thus checked for discharge compliance. Drinking water sources in 15 states--Connecticut, Missouri, Georgia, New York, Washington, North Carolina, Pennsylvania, Utah, Colorado, Florida, Tennessee, Iowa, California and Texas--are monitored routinely for the metal. In Missouri and most of the other states, chromium, like other trace metals, is determined infrequently--every one, two, or three years. None of the data reveals any appreciable amounts of the metal in any drinking water supply, and invariably the levels are below the APHA's limit of 0.05 ppm hexavalent chromium. In many cases trace amounts are below levels detectable with atomic absorption spectrophotometry.

The water pollution agency in the County/City of Jacksonville, Florida, monitors chromium in streams that receive waste from plating industries or from utilities that use chromium salts as anticorrosive agents in cooling systems. It was noted that waste water from air conditioning equipment is suspected by the agency of containing chromium salts. The agency has expressed concern over the difficulty of determining the chemical constituents of such materials, as they only carry trade names without labels indicating their chemical composition. However, the

chemical analyses done on water samples from streams receiving the effluent have not shown any excessive concentration of chromium.

In review of discussions with state agencies and an assessment of available state data, there is no major pollution problem evident with chromium with regard to reported health effects in any area of the environment. Nevertheless, all the states are quite aware of the potential deleterious effects of chromium and have indicated their decision to continue monitoring it in sensitive areas of the environment.

Cyanide

Cyanide has been well known as a very potently toxic substance. Research has shown that the presence of cyanide in water will inhibit biologic activities. For example, it was shown that above 0.1 mg/liter the substance is toxic to fish and above 0.3 mg/liter it inhibits the activity of the bacteria responsible for self-purification of rivers. Its toxic effects on the human system are also well recognized. However, none of the 20 states visited reported any problem of cyanide pollution. Furthermore, most of the states do not monitor for it routinely. A common reason raised is that the cyanide ion is very unstable in the presence of certain chemicals and hence it is not easily detected. For example, the ion is destroyed by chlorine molecules in water. Since cyanide is most likely to be transported by waste water or potable water, both of which have a chlorine residual from treatment, it would not be detected if it were tested for in such waters.

Cyanide salts may enter the environment as components of industrial wastes and can therefore be transported by water into aquatic systems. Likewise, solid materials containing cyanide disposed in dumps and landfills could leach into surface or groundwater. Tennessee and Florida have ongoing programs to monitor streams in their discharge surveillance networks, and Connecticut and New York have recently initiated programs to monitor solid waste areas for it. The data collected thus far from these states indicates very low levels or levels below detection limits. Other states monitoring water supplies are Oregon, Tennessee, Utah, North Carolina, Colorado, Florida, New York, Georgia, Missouri, and California. In every state there have been no significant values reported. For example, the 1972 water quality data from the state of New York shows that 167 systems were checked for cyanide and at least 97 percent of them showed no cyanide. For those that indicated its presence, none was above the allowable limit of 0.2 mg/liter. All of these states report that they use standard colorimetric methods which are recommended for waters with low concentrations of cyanide.

While all the states seem to recognize the very toxic nature of cyanide, it is not viewed by them as a pollutant which poses any immediate hazard in any area of the environment and is one of the least monitored of the eight toxic substances.

Lead

For at least several hundred years the health effects of lead poisoning have been recognized. More recently, acute and chronic lead intoxication from inhalation of fumes or ingestion of food, drink, or materials containing high levels of lead has been shown to impair blood-forming mechanisms resulting in anemia; cause gastrointestinal bleeding; damage the kidneys and heart; and, in advanced cases, attack the nervous system resulting in death or permanent injury. Chronic exposure to lead is a serious problem because over and above a certain body burden level where lead uptake is balanced by excretion through normal processes, lead tends to accumulate in the system. Except in cases of massive and acute exposure, lead accumulates gradually over time, and the resulting illnesses develop slowly and are difficult to identify.

Besides its extreme toxicity, the principal reason lead is of concern as an environmental contaminant is that it is found in virtually all media of the environment. Lead is useful in such a wide variety of applications that there is consequently more of it produced commercially than any of the other toxic heavy metals. Some of the more commonly known products with lead as a constituent are batteries, paints, plastics, stabilizers, ceramic glazes, food can sealants, and leaded gasoline. From these kinds of products, as well as from the basic mining and smelting processes which produce the metal, and natural lead sources, lead enters all areas of the environment. In all 20 states contacted, some lead at least in trace

amounts had been found in the water, in air, and in ceramics, food, and human blood.

Many of the state agency officials were aware of the more familiar cases of acute lead poisoning in the literature. These cases involved inhaling lead fumes from burning automobile batteries, exposure of workers in the smelting industry, and exposure of workers in the production of leaded gasoline. Chronic environmental, as opposed to industrial lead intoxication cases were also known to the state agencies. These were generally of two types: ingestion over a period of time of food and drink from ceramic containers which leached lead, and exposure through pica of young children in older houses where paint contains high levels of lead. The latter type of case was known to be a common problem in large cities with old housing areas, especially in the east and industrial midwest. As regards airborne lead, states were aware of the role of auto emissions and specific industries such as smelters and refineries; they were also aware of the difficulty of establishing a clear cause-and-effect link between levels of lead in the air and adverse health effects.

As a result of public concern, legislative requirements, and a widespread awareness among state monitoring agencies of the potential problems of lead as an environmental toxic substance, lead was monitored by agencies in one or more media in all 20 states contacted. The two most prevalent media where lead data was generated were

drinking water supply and food and food-related materials, since these were the areas where human exposure and consumption are direct. Water supply agencies in all the states included lead among the toxic metals which they monitored. With the exception of several of the more than 1,000 water supplies analyzed for toxic metals for the first time in Missouri, reported lead levels in the public water supplies in the 20 states were below the Public Health Service standard of 0.05 mg/l. In the majority of cases, lead levels were below the detectable limits of the atomic absorption analysis methods employed. Because levels were consistently low, and because of the large number of supplies to be sampled, any given public supply in the states would generally have lead analysis done only once every two or three years. In summary, lead contamination of public drinking water supplies is not viewed as a general or widespread problem by the states, but because of the toxicity of lead and the potential hazard, lead is a substance requiring periodic monitoring.

Food and food-related materials are monitored sporadically for lead content by state agricultural agencies, health departments, or both to some extent as in the states of California, North Carolina, and Michigan. For the most part, samples are analyzed for lead because of a complaint or request from the public. According to agency officials, there is usually a spate of such requests whenever there is press coverage of the rare occurrences of lead poisoning from food or utensils. On the rare occasions where agencies detected

high lead levels in food (none of which were reported in the data for 1971-1974 time frame), the source was believed to be lead used in solder in the food canning process. According to a spokesman for the National Canners Association contacted during the course of this project, improved canning techniques have now largely eliminated this source of lead in food. Lead from utensils--principally earthenware cups, pitchers, bowls and casseroles with lead glazes--were more frequently tested for lead than was food. In each of the 20 states, the health and/or agricultural agency has done some analysis of lead leaching from ceramic samples. After a high-interest period in the early 1970's, the number of samples analyzed has now dwindled to about 10-20 per state per year. Agencies now report that detection of lead leaching is rare, and it is even more rare that levels exceed the 7 mg/l which the FDA considers the safe limit for use with food or drink. State health officials in California indicated that a bill has been drafted to safeguard against lead contamination from foreign pottery. This is expected to be achieved through independent chemical analyses of materials used in the manufacture of utensils. The largest amount of data on utensils was obtained from the Colorado health agency, where 824 samples were analyzed from 1971-1974. Of these, 687 resulted in no lead detected. In cases where the FDA limit was exceeded, the sample was returned to the owner with the warning that it should not be used to contain food or drink.

While the major toxic substances monitoring involvement of state fish and wildlife agencies has been with mercury analysis, several

have also monitored other substances including lead. In Colorado, bioassays were underway to determine maximum acceptable toxicant concentrations of lead and several other metals on fish and aquatic insects. The objective of that effort was to develop proposed standards for levels of toxic substances in water, and to determine if insects could be used as indicators of toxic substances contamination. Besides bioassays, ambient samples were also analyzed. While insufficient samples were taken for firm conclusions to be drawn, the results indicated that organisms tend to accumulate significant amounts of lead even when the water environment contains only small amounts of the substance. A toxic metal survey in Massachusetts, which included analysis for lead in shellfish and finfish, similarly indicates that aquatic organisms will tend to accumulate lead at a higher level than that present in the surrounding water. Sources in Colorado were believed to be mine drainage and natural occurrence, while Massachusetts officials attributed lead contamination to a variety of industries and treatment plants discharging into the state's waterways. Besides fisheries, another concern with lead was poisoning of game birds through ingestion of lead shot. Data from Washington and Colorado indicate that ingestion of a single pellet may cause lead poisoning in birds. The problem was sufficiently widespread in one area of Colorado that hunters were required to use steel shot only.

Lead is monitored by the majority of state water pollution

control authorities. Many of the larger water monitoring programs, such as in Pennsylvania, New York, North Carolina, Tennessee, Colorado, Oregon, Utah, and others, report their data on a routine basis to the Federal STORET system. All of that water analysis for lead, consequently, was not acquired by MITRE during this project. From the remaining data that was acquired and analyzed on lead in surface and groundwater, levels were found to be significantly high only near areas where mine drainage has occurred as in several western states and the Missouri lead belt; and in areas with industries and treatment plants discharging into water. In the Massachusetts toxic metals survey discussed earlier, river water samples analyzed for lead in 1972 averaged 1.17 mg/l, with a maximum of 190 mg/l. For the same year, sediment samples had a mean of 150.87 mg/kg and a maximum of 2,000 mg/kg, indicating considerable accumulation of lead in bottom sediments.

State air quality agencies are presently required to monitor only those air pollutants for which standards have been established, and lead is not included among them. Nevertheless, reflecting concern with the estimated 180,000 tons of lead emitted annually by mobile sources and additional emissions from local industrial sources, many air agencies analyze their total suspended particulate samples for lead content. While there is no national standard for airborne lead as yet, there appears to be consensus, as state agencies see it, among EPA and other organizations, such as the World Health Organization

and the National Academy of Sciences, that lead in the amount of 2-3 $\mu g/m^3$ of air may result in higher than normal blood lead levels in humans. Most state air agency lead monitoring consequently is routine population and background-oriented to determine if existing levels are near the 2-3 $\mu g/m^3$ range. Analyzed results of lead monitoring in Pennsylvania, Connecticut, Georgia, Tennessee, Texas, California, Michigan, Florida, Missouri, Oregon, Delaware, and New York reveal that with the exception of one or two source-oriented sites per state, annual averages are usually less than 2 $\mu g/m^3$. Two exceptions to these lower background levels are evident in the results of data analysis from specific source-oriented monitoring conducted in California and in El Paso, Texas.

The California survey was made following lead poisoning among horses in the Carquiney Strait area of Northern California. The concern was that if horses were affected, hazardous levels of lead may be entering the human food chain from airborne lead as well. A several-year study in communities in the northern and southern areas of the state monitored air concentrations of lead, lead in food from local groceries and home gardens, and blood lead levels of children and adults in the study communities. Air samples from the southern communities frequently exceeded 2 $\mu g/m^3$, with a maximum level of 10.5 $\mu g/m^3$; in the northern communities, where lead poisoning had been found in the horses, samples never exceeded

1 $\mu g/m^3$. From the data on the wide variety of food samples from all areas, it was concluded that no significant amount of lead would be ingested through the food chain, and no significant area differences were present. Blood lead levels from the northern communities were not in the range likely to be clinically important; and the levels in the southern communities, while somewhat higher, were well below the 40 $\mu g/ml$ considered by the U.S. Surgeon General to be indicative of undue lead absorption. In summary, the data generated was inconclusive and analysis did not tie airborne lead levels to significant human hazards either from the food chain or from inhalation.

In 1971, the El Paso City-County Health Department, in an investigation of a large smelter preparatory to a court case brought for violations of Texas sulfur dioxide and particulate regulations, learned that the smelter had emitted 1,012 metric tons of lead in the period 1969-1971. As the local officials were well aware of the potential health hazards of exposure to lead, the scope of the investigation was immediately broadened to include monitoring of human exposure to lead in the air. First, air filter samples from 1969-1971 were analyzed for lead; then, after consultation with several recognized authorities on the relationship of airborne lead to human health, blood lead levels were determined for a sample of the El Paso population. Results showed that 43 percent

of those tested living within a mile of the smelter had levels exceeding 40 μg/ml, and that this decreased to one percent two miles from the smelter. At this point, extensive sampling was undertaken including air, dust, soil, paint, food, water, and pottery; and the Center for Disease Control in Atlanta was asked for assistance in human health effects testing.

The findings indicate that ambient air near the smelter contained very high concentrations of lead: 92 $\mu g/m^3$ annual mean in 1971, and 43 $\mu g/m^3$ mean from June 1972-July 1973. Much of the lead was in the respirable size range. No other stationary sources were found to emit significant amounts of lead, and correlations of lead-bromine ratios in dustfall data indicated that mobile sources accounted for only a small portion of the lead content. Dust analysis also showed a geographical distribution of lead content similar to high blood lead levels, indicating that where highest levels of lead would be inhaled or ingested, blood lead levels were higher. The data on soil analysis was less conclusive and showed no clear relationships. Paint ingestion could not account for age and geographic distribution of lead absorption, although there was some evidence that children did ingest lead-based paint. Lead in food and water was found to be negligible, and only 2.8 percent of households had pottery with potentially dangerous lead content. On the basis of the data gathered, the El Paso agency concluded that at least within a one-mile radius of the smelter, the smelter was the principal source of lead in the

environment. The courts have concurred, and the smelter is enjoined from discharging hazardous metals and has paid damages and medical payments for those suffering chronic lead poisoning in the El Paso area. At present, except for the area immediately adjacent to the smelter from which people were relocated, ambient lead levels are below 2 $\mu g/m^3$.

Blood Level Studies

Many cities throughout the country have conducted blood lead screening and, on occasion, performed studies in attempts to determine the sources of elevated blood lead levels. For several reasons, data from most of these activities was not acquired in the course of the project. Most of the meetings with state agency officials were held at the state capital, and if the capital city or a state agency had a lead program, then an attempt was made to acquire that data. With the priority of getting as much data as possible on 17 toxic substances from as many state agencies as possible, however, it was not considered resource- and time-effective to attempt to acquire blood lead data from every city in each state which might perform some lead screening. There were additional problems with patient confidentiality, and the situation where the results of many programs were already being reported directly to the CDC in Atlanta. Nevertheless, data on some blood screening was acquired in the course of the state meetings. In general, results from California, North Carolina, Washington, Massachusetts, New Jersey,

St. Louis, Missouri, and Allegheny County, Pennsylvania, indicated that elevated blood lead levels in children, while still a problem in the older sections of large cities, is becoming somewhat less serious than was the case in the 1950's and 1960's when lead intoxication of inner city children was more common. Then, as now, the major source of the lead exposure is believed by agency officials to be a children's habit referred to as pica, which involves eating such materials as soil, flaking paint, and plaster, containing significant amounts of lead. When agencies' blood lead screening showed results over the generally accepted threshold of 40 μg/ml, household inspections were conducted and orders were issued to remove and/or repaint surfaces where paint was found to have high lead content. Although several agencies (e.g., Allegheny County) attempted to determine sources of high blood lead levels other than ingestion of paint, all studies except the El Paso case discussed above were inconclusive in their results. While agencies involved generally believed that airborne lead in particulate and in settled dust contributed to elevated blood levels, actionable data was only available on lead-based paint ingestion. Another study, also involving a lead smelting complex, is underway in Kellogg, Idaho, with a joint task force involving the state, EPA, and CDC. A similar comprehensive monitoring approach to that used in El Paso is being employed, and data on the results of analysis should be available from EPA in the near future.

Mercury

The problem of mercury pollution has been recurring in the United States during the last thirty years ever since mercury poisoning was first reported in 1935 by the American Medical Association. In that instance a study was made of 529 workers in the fur cutting industry where a mercury solution was used. It was found that about 42 of the workers were chronically poisoned with mercury. Between 1953 and 1960, 111 persons in Japan were severely disabled and 43 were killed as a result of consuming fish taken from Minamata Bay which had been contaminated with mercury from industrial wastes. In addition, 19 babies born to families from the same region had congenital defects even though their mothers showed minimal or no symptoms of mercury poisoning. Another episode of mercury poisoning was reported in the Japanese island of Hon Shu in 1965. In that instance 26 persons were poisoned and five subsequently died. The source of mercury was determined to be fish containing 5 to 20 ppm mercury which was derived from industrial waste discharged in water and consumed by the fish. One of the first reports of mercury poisoning in the United States was made by the Center for Disease Control (CDC) in Atlanta in 1970. The case concerned the consumption of pork by a family in New Mexico from hogs which had eaten mercury-treated grains. High mercury levels were found in the home-butchered hog and in the treated grain which had been fed to it. Abnormally high concentrations were also found in human samples taken from three of the ill family members as well as three other members who

had not become ill. In the reported cases where mercury toxicity has been established in humans, the hair and kidneys are found to have the highest levels. The damages associated with it include brain damage, kidney malfunction and muscular atrophy. It has also been established that pregnant mothers transmit the substance rapidly to fetuses and many congenital damages to infants have been linked to mercury poisoning.

Because of the deleterious effects of mercury, many of its uses in medicine, agriculture and industry have been banned and/or curtailed. The activities of states in monitoring mercury have involved most media and have essentially been confined to areas where pollution is known or suspected. Monitoring activities were somewhat set back by the uncertainty of analytical methods in more unconventional media such as fish and animal tissue. Initially, interlaboratory testing provided poor reproducibility of data in some states, but with improved instrumentation and specially trained laboratory personnel, most state laboratories have achieved acceptable analysis for mercury in many media.

Mercury was of concern to the health and environmental agencies in all of the 20 states contacted. The results from the surveys showed that in those states that identified mercury pollution, the source was usually believed by agencies to be from industrial wastes. In Massachusetts, mercury entering surface and ground water systems was believed by state officials to originate from a dye manufacturing industry that used mercury. In Georgia, mercury wastes were traced by state agency officials to caustic soda and chlorine manufacture (chlor-alkali industry). Texas agencies reported mercury pollution from the aluminium

industry as well as from mercury smelting operations in areas of naturally occurring mercury deposits. The pollution in the state of New York has been linked by officials there to the decomposition of naturally occurring rocks. In Tacoma, Washington, airborne particulates from a copper smelter were believed to be the cause of mercury deposits found in nearby soil samples.

Mercury can enter the environment as liquid industrial waste, airborne emissions from mining operations, or from other sources where it is used, such as hospitals and agricultural processes. The chemical form (organic, inorganic, or elemental) present varies according to the source. It exists as inorganic chemical compounds in the waste from chlor-alkali industry; it vaporizes from hospitals and other laboratories as elemental mercury; and it is found in agriculture, where it is used as a fungicide, as organic mercury (ethyl, methyl or phenyl) derivatives. In any of these forms, the substance is transported by air or water or soil and may cause contamination in any of these forms. The organic species are considerably more soluble in water and are also determined to be more toxic to organisms. In water systems--rivers, ponds or lakes--mercury travels rapidly to the bottom because of its high density and insolubility. From the sediments, it is picked up by aquatic fauna and flora. Fish may ingest it directly through their gills or from other food such as planktons or smaller fish. Further, mercury tends to adhere to organic material from which bacterial activity catalyzes its transformation into organic forms. When mercury

enters the body of an organism, it tends to accumulate as it seems to be eliminated slowly.

The publicity resulting from the reported episodes of mercury poisoning prompted environmental agencies in all 20 states to initiate surveys to determine the extent of mercury contamination. Monitoring in those states contacted has been concentrated on water supplies, seafoods and agricultural products. The ambient levels reported vary greatly from state to state as well as within states. A summary of the most significant programs follows.

In Massachusetts, one industry used mercury in its process of manufacturing dye. Consequently, very large concentrations were present in the effluents that left the plant and ended up in the Sudbury River system by way of a small brook. A survey conducted to investigate the mercury problem in the state estimated that over a 30-year period in excess of 100,000 pounds of mercury were carried into the river from this plant. It was further estimated that between 25,000 and 35,000 pounds of the metal are presently contained in sludge deposits on property in the vicinity of the plant. Levels as high as 4,985 ppm were recorded in 6-18 inch core samples taken from the property. Surface water samples analyzed recorded as much as 57 ppm mercury. Sediment samples taken from a pond which received water from the contaminated brook showed as much as 1,500 ppm mercury. Over 90 percent of this concentration was in the top 12 inches. The levels of mercury discussed above were reported as total mercury, and

methyl mercury was estimated by the state agency to be less than one percent of the total value. Groundwater samples taken from test wells in the vicinity of mercury disposal sites showed high levels of as much as 4,300 ppm as total mercury and 3,300 ppm as dissolved mercury from a 41-foot well. The concentration was somewhat lower for a shallower well (12-feet deep), where values as high as 148 ppm and 118 ppm were found for total dissolved mercury respectively. One disconcerting implication of this data is that an area which was a recharge zone for the underlying aquifer was overlain with concentrated mercury deposits which were contaminating the groundwater. These waters apparently were not used for drinking and would be totally unsuitable for that purpose as US PHS standards would not allow more than 0.05 ppm mercury in drinking water supplies.

Another survey was done on the Taunton River system in Massachusetts which receives mercury wastes from another industrial user of mercury. Samples taken from sections of the river bed showed levels which were as high as 173 ppm mercury, and other samples from an estuarine area showed total mercury as high as 131 ppm. In another trace metal investigation of the Boston Harbor, sediment analyses showed mercury concentration of 0.92 to 5.70 ppm mercury. The Massachusetts Division of Fisheries and Game conducted two mercury surveys between July 1970 and March 1972. In the first one, fifty-nine (59) fish from seven species taken from 27 random statewide sites, were analyzed and showed mercury between 0.03 and 1.36 ppm. Twenty-two fish had concentrations greater than

the F.D.A.'s limit of 0.5 ppm. In the second survey, 148 fish made up of yellow perch and largemouth bass, were analyzed. The results varied between 0.0 and 12.43 ppm. The data from this as well as others in the different states established a direct relationship between the concentration in a fish and its size, weight, length, and age. The data from 211 shellfish analyses over four years (1971-1974) showed mean levels between 0.33 and 0.39 ppm mercury. Between 1971 and 1972, 413 statewide water samples were analyzed for mercury with mean values between 0.0002 and 0.012 ppm mercury.

Mercury investigation in Georgia between 1971 and 1974 revealed significant contamination of biota from two major river systems in the state. In 1971, 143 fish representing 20 species of finfish were analyzed from the Savannah River with mean values between 0.07 and 1.54 ppm. During this same period 14 species of shellfish and finfish (97 fish) from the Brunswick River indicated mean values between 0.08 and 1.57 ppm. For 1972, 136 samples from 16 species of finfish from the Savannah River were analyzed, and mean values varied between 0.23 and 1.45 ppm mercury. From the Brunswick River, 140 samples from 14 mixed species (fin and shellfish) gave mean values between 0.21 and 1.79 ppm mercury. For 1973 and 1974 over 200 samples from 27 species of finfish were done and mean levels varied between 0.21 and 1.35 ppm of the metal. These results indicate substantial contamination from two rivers that were the recipients of mercury waste from two chlor-alkali industries.

Both rivers were closed to fishing for human consumption. In addition, water fowl and their food were analyzed for mercury. Sixty-three bird samples showed levels between 0.01 and 9.45 with a mean of 1.72 ppm, while 48 samples of food gave between 0.12 and 16.8 with a mean of 1.88 ppm mercury.

In Texas, a mercury survey was concentrated around estuarine areas as a result of mercury wastes discharged into Lavaca Bay from aluminum operations. This bay showed the highest levels in the biota sampled. Between 1971 and 1974, over 200 samples of fin and shellfish were analyzed and mean values ranged from 0.02 to 1.0 ppm mercury. In addition, fish samples were taken from the Concho and Rio Grande Rivers and analyzed for mercury. The five species sampled from the Concho varied between 0.11 and 0.55 ppm. In over 135 samples taken from nine species of finfish recorded mean values were between 0.16 and 0.84 ppm. These two river systems were thought to receive drainage from areas with natural deposits of mercury from which the metal is mined.

In California, an Interagency Committee was formed in 1970 to investigate mercury levels in the environment with samples from fish, game birds, water, and sediments. The fish data derived from 151 samples from 18 species indicate a range of 0.0 to 1.27 ppm, with over 30 percent exceeding the 0.5 ppm tolerance limit. Of 20 samples of harbor seals analyzed, a range of 0.23 to 3.10 ppm and a mean of 1.1 ppm mercury was determined. As in most states, water supplies were

generally below detectable limits. The biota showed significant mercury concentration, further substantiating the concept of biomagnification through the food chain from low ambient levels in water and substantial concentrations in sediments.

The Wildlife Division of the Michigan Department of Natural Resources monitored birds and mammals for mercury. Included were ducks, pheasants, miscellaneous mammals, and birds. Over 267 samples were analyzed but only two varieties of ducks showed levels in excess of the F.D.A.'s 0.5 ppm. One set of 39 samples had a range of 0.01 to 1.76 ppm with mean of 0.65 and the other set of 32 samples ranged from 0.18 to 1.76 ppm with a mean of 0.76 ppm mercury. Wayne County in Michigan is one of the few jurisdictions in the nation which tests for mercury in Hi-Vol particulate samples. Quarterly composite samples for 1972 revealed values of 0.05 to 2.63 of $\mu g/m^3$ of mercury in the atmosphere.

Fourteen (14) samples of sediment from estuarine areas in Washington were analyzed for mercury. Levels of mercury revealed a range of 0.9 to 7.8 ppm. Thirty-seven wild pheasants were sampled and the results showed only five birds had levels in excess of 0.5 ppm mercury, with high values of 4.8 and 4.6 in liver and breast tissues respectively. In a study of metals emitted from the Tacoma smelter, five soil samples were analyzed for mercury and results ranged from 2 to 10 ppm. The samples were taken from the vicinity of the smelter so the source of the metal was linked by state officials to the deposition of

of airborne particulates from the smelter.

A shellfish survey for heavy metals showed very low levels of mercury in Connecticut. In over 85 samples analyzed, values ranged from 0.0 to 0.18 ppm mercury.

A study was conducted to determine mercury levels in food samples in various areas of Idaho. The samples included beef. pork, poultry, grain, eggs, dry cereals and a variety of other foods. The results showed that none of the foods tested which were consumed by humans contained organic mercury in excess of the 0.5 ppm FDA limit. The highest level observed was 0.4 ppm in a sample of chicken liver. Generally, all the foods with the exception of poultry and red meat (pork and beef) were negative or contained very low mercury levels.

In a survey using 246 pheasants over a one-year period, it was found that the highest levels of mercury contamination occurred in the spring. This indicated that the pheasants ate mercury treated grains planted during the spring. One set of 90 birds was collected in June and July of 1970. It was found that 80 percent contained detectable mercury residues. The mean level was 1.12 ppm and the range was from 0.05 to 7.6 ppm. Forty-three (43) percent exceeded the 0.5 ppm limit. These findings prompted the Idaho Department of Health to make certain recommendations regarding the consumption of pheasants. These included

a caution not to eat more than one meal of pheasant per week, a suggestion to discard the back and giblets, and a warning that pregnant women should avoid eating foods with suspected quantities of mercury. Farmers were also advised to clean up treated grains and to use phenyl-mercury instead of methyl- or ethyl-mercury treated grains.

In 1970 a total of 160 fish samples from 19 species were collected and analyzed. Ninety-eight (98) percent showed detectable levels of mercury with the highest level of 1.7 ppm in squawfish. A total of 19.3 percent exceeded the 0.5 ppm limit. The data suggested that channel catfish, yellow perch and suckers accumulate higher mercury levels than other species from the same waters. Fish from reservoir sections of Snake River contained higher mercury concentrations than those from the free-flowing sections of the river. The contamination of Idaho waters with mercury has been traced to naturally occurring mercury ores and to massive spills of mercury during mining operations of the late 1800's. These findings also resulted in the State Health Department promulgating guidelines to citizens similar to those for pheasants. In addition, fishermen were advised to practice "catch and release" in the Jordan Creek and Snake River reservoir which were determined to be contaminated with mercury.

Conclusion

The other states from whom data is available did some surveys, but none reported any serious contamination from mercury. New York had

a localized problem of contamination from natural sources of mercury, but studies have not become available as of the time of this writing. In summary, the examples cited above show that mercury pollution has been strongly evidenced in the aquatic eco-systems and has affected the fauna from those systems more than any other facet of the environment.

One result of the series of surveys and investigations which were initiated throughout the country in the early 1970's was the reassurance that mercury was not as widespread in water and food in the public marketplace as initially feared. Invariably, all water supply systems revealed none or exceedingly low amounts of mercury in water that was being publicly consumed. On the other hand, the findings did delineate some features of mercury pollution. For example, contamination of fish in areas receiving mercury pollution was found to vary directly with length, size and, less clearly, with the age. It is also related to positions in the food chain--those fish highest in the chain tend to have larger amounts of mercury than was true of those that feed among the bottom layers.

In states that identified high levels of the substance in commercial fishing areas, those areas were closed and/or closely monitored. In Georgia, sections of the Savannah River and the Brunswick River were closed and when the sections were reopened, residents were cautioned to avoid excessive consumption of fish from those areas. In Texas, the oyster industry was adversely affected by the identification of mercury in Lavaca Bay. Such occurrences resulted in economic loss

to the local fishing industries but the extent of such losses have not been documented. Whereas the toxic nature of different forms of mercury has been documented in several publications based on research done throughout the world, none of the state agencies contacted have noted any human fatalities or cases of poisoning resulting from the consumption of mercury-contaminated foods or from industrial exposure to the metal or its compounds. This, however, might only reveal a lack of correlation of data between medical examiners' offices, hospitals and clinics and other agencies rather than substantiate the absence of mercury-related illnesses or deaths.

Polychlorinated Biphenyls (PCB's)

Polychlorinated biphenyls were introduced in the United States of America in the 1930's and their production was rapidly increased to about 34,000 tons in 1970. Up to that time they were widely used in industry for many purposes such as platicizers, insulating fluid in electrical devices (transformers and capacitors), and as solvents. It was not until 1968 that PCB's were identified as injurious to human health. This came about as the result of the outbreak of Yusho disease in Japan. The cause was traced to the consumption of food which had been contaminated with a PCB chemical. Although no incidents of poisoning in humans have been reported in this nation, many states have been aware of the potential hazard of PCB's and have been quick to investigate episodes of contamination of agricultural foods and fish. The concern over PCB's resulted

from the similar biochemical characteristics which they exhibit with DDT and its other analogs. These include toxicity to many organisms and wildlife (0.4 ppm has been shown to be toxic to shrimp); biomagnification in the food chain; and pervasive persistence in the environment. The literature on PCB's estimates that over 4,000 tons of these substances entered the nation's waterways annually up to 1970.

The laboratory determination of PCB's in the states visited is relatively new and resulted from an almost inadvertent discovery of interferences in pesticide residue analyses in the late 1960's. Most of the states worked closely with the FDA on the methodology for PCB separation and identification and are now capable of making the determination routinely, although a few states have indicated the need for more sophisticated gas chromatograph instrumentation.

One of the first episodes of contamination reported in the U.S. was the identification of PCB's in oysters from Escambia Bay, Florida, in April of 1969. A survey revealed contamination of sediment, water and shellfish. This incident was traced to leakage from an industrial plant 6 miles upstream from the Bay. The leak was stopped but PCB's continued to be present in the bay although in decreasing amounts. At the time of the Florida visit many environmental agencies referred to this episode, which was published in the Bulletin of Environmental Contamination and Toxicology in 1970. Fishing was suspended in the bay but has since been resumed. Because of the past problem of PCB contamination cited in Florida, the state Department of Pollution Control (DPC) has noted that

efforts are being made to discourage the use of PCB's in old electrical equipment and new installations are being required not to use PCB's in their systems. PCB's are currently monitored in water and sediments by the DPC and in foods by the Pesticide Residue Laboratory, state Department of Agriculture.

In Massachusetts there was a survey between 1971 and 1973 to determine PCB's in fish from rivers throughout the state, and also to use mussels as indicators of PCB pollution. In the first study, levels of PCB's as high as 32.8 ppm were determined in fish from one of the rivers. A second survey revealed levels of PCB's as high as 79.5 ppm in fish, while uncontaminated mussels introduced in suspected areas showed PCB's as high as 36.5 ppm. This presence of PCB's was traced by state officials to an electrical components manufacturer adjacent to the area of the stream found to have fish with the highest concentration of PCB's. The sediment from this area was also high in PCB's. The study also served to test laboratory methodology for the identification and quantification of PCB's and other chlorinated hydrocarbons.

The Georgia and North Carolina Departments of Agriculture reported a major incident of PCB contamination of chickenswhich occurred in 1970. A number of chickens had died and there was an evident thin-egg-shell phenomenon which threatened chicken farmers in several states in the region. The contamination was traced to affected feed eaten by the chickens. In an extensive survey which followed, PCB's were detected in a wide variety of chicken and other farm products including eggs, tissue,

milk, silage, feed, nesting material and compost. Very large values of PCB's were recorded in many of the media tested. The highest was found in nesting paper (shredded IBM paper), which had up to 32,000 ppm PCB. A water survey was also carried out in 1973 from 39 stations on streams from 11 river basins to determine PCB's. Fifteen samples showed significant levels of PCB's ranging between 0.009 and 1.800 ppm. The source of this was also traced to an electrical components manufacturer. In Texas two surveys were made for PCB's. The first one done by the Health Department in the Rio Grande area between 1969 and 1972 dealt with 221 samples of human fatty tissue obtained from elective surgery. Seven percent of the samples (15) showed PCB's ranging from 0.0 to 10 ppm and a mean of 0.1 ppm. In the second, the Department of Agriculture analyzed 433 sediment samples over a 23-month period which began in 1970. The samples were taken from 50 stations on eight major Texas rivers and three smaller streams. A total of 40 samples showed PCB's with a mean of 0.16 ppm. The source of PCB's in the rivers was not identified, but it was believed by state officials to be an industrial discharger.

The Iowa Pesticide Residue laboratory of the Department of Agriculture picked up PCB's in fish and fishmeal. Further studies were done and some samples of fish (carp and buffalo fish)were found to have significant levels of PCB's. These kinds of fish had been used to manufacture fishmeal which was also found to have correspondingly high levels of PCB's. Iowa has established a maximum allowable level of PCB's in food of 2.0 ppm. Analyses of 20 samples of fish showed PCB values be-

tween 0.18 and 10.26 with a mean of 2.15 ppm. Further investigation was occurring but the source of the contamination was not determined at the time of the visit.

The monitoring activities for PCB's in the twenty states have been centered around four areas. They are agricultural products; fish and other animal tissue; water and sediments from water bodies; and human tissues. Most states report their findings as aroclor, specifically Aroclor 1248, 1250, or 1260. These designations are references to the manufacturer's trade names, and refer to the percentage composition of chlorine and the aromatic constituent of the PCB's. Aroclor 1248 denotes 12 percent of the aromatic constituent and 48 percent chlorine, while 1260 would likewise denote 12 percent aromatic and 60 percent chlorine. None of the states indicated any differences in toxicity of the various forms and seemed to have treated each with equal concern and attention. The PCB's reported most frequently from the surveys were 1260 and 1248 or were just reported as PCB's. Apart from known or suspected cases of PCB pollution the agencies do not monitor routinely for PCB's in fish or water, and no case of PCB monitoring in air was reported by any state. This is surprising in view of the emissions reported in the literature of over 1,000 tons of the substance to the air, primarily from plasticizing industries. The state agency which usually screens routinely for PCB's is the pesticide residue laboratory which in most states comes under the state department of agriculture. This laboratory functions primarily as a pesticide regulating body. A wide range of substances, including fruits,

vegetables, dairy and poultry products, are examined frequently to ensure safety from pesticides. PCB's can be identified qualitatively on the gas chromatograph when analysis is done for pesticides. When this identification occurs most of the states further check samples to quantify the amount of PCB's present. The states with such capability are Connecticut, Georgia, New York, Florida, Tennessee, Oregon, North Carolina, Michigan, Utah, Pennsylvania, California and Iowa. States that did a survey for PCB's in fish are Michigan, Massachusetts, Georgia, New York, Florida, and California. Most states do not monitor their water supplies for the biphenyls, but whenever they are suspected analyses are carried out. Twelve states have tested water and sediments for PCB's (see Table 11).

PCB's continue to be of interest to these states. Where industrial contamination was identified, as in Florida, Georgia and Massachusetts, agencies were able to get the industries to curtail or discontinue their use of the substances. Although PCB's have been found in fatty tissues (in which they have been found to accumulate) from humans, there have been no reported cases of poisoning or illness in any of the 20 states. Only Iowa among these 20 states has an "action limit" on PCB's of 2 ppm. The others have reacted to episodes of contamination of food products by closing fishing areas or taking foods off the market.

Other Toxic Substances

There were nine other toxic substances on the list of those of interest to OTS. These were: aryl phosphates; benzene; 3,3' dichloro-

benzidine; ethylene glycol; hydrazine; methyl chloroform; "Moca" (4,4' methylene bis 2 chloroanaline); α napthylamine; and acrylonitrile. None of these nine substances were routinely monitored by any agencies contacted in any of the program areas. However, several agencies had done limited testing for benzene and methyl chloroform in water recently. These were specifically the Connecticut Health Department and the Iowa Hygienic Laboratory, which analyzed some samples in connection with occupational health programs; and the Florida Department of Pollution Control, which conducted some limited analysis of water samples for organics. In none of the three instances was data available for inclusion in this report.